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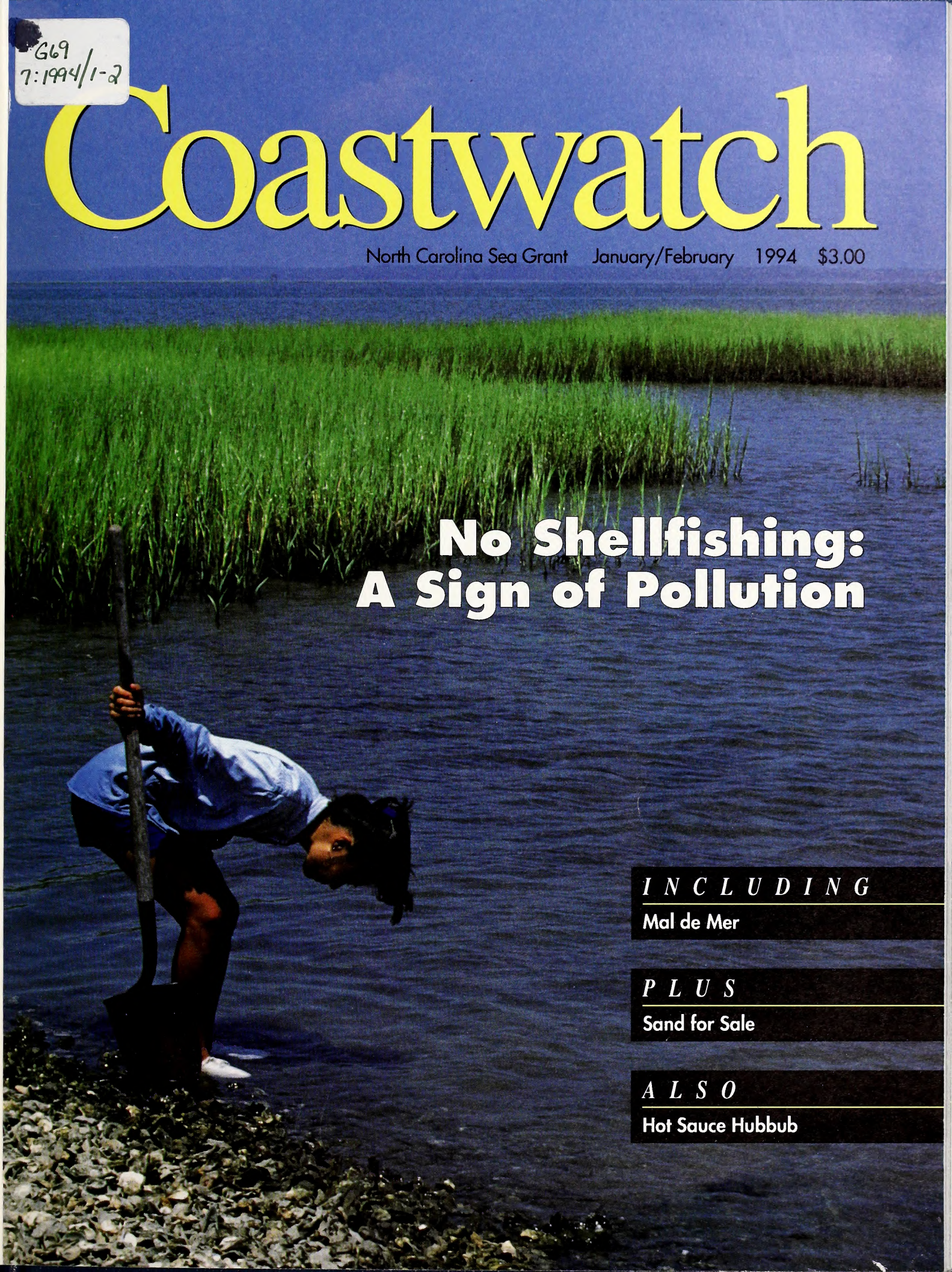
North Carolina Sea Grant January/February 1994 $3.00



No Shellfishing: A Sign of Pollution

INCLUDING

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PLUS

Sand for Sale

ALSO

Hot Sauce Hubbub

Coastwatch

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, N.C. Sea Grant supports several research projects, a 12-member extension program and three communicators. B.J. Copeland is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

Coastwatch (ISSN 1068-784X) is published bimonthly, six times a year, for $12 by the North Carolina Sea Grant College Program, N.C. State University, Raleigh, NC 27695-8605. Telephone: 919/515-2454. Fax: 919/515-7095. Second-Class Postage paid at Raleigh, N.C.

POSTMASTER: Send address changes to *Coastwatch,* N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Front cover photo of Bogue Sound by Scott D. Taylor.

Inside front cover photo of sand dunes at Waves by Michael Halminski.

Printed on recycled paper by Highland Press Inc. in Fayetteville, N.C.

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The fluorescent green signs that flag a closed shellfish area are an all too common sight in North Carolina's tidal creeks and sounds. Experts believe that recent increases in polluted runoff — called nonpoint source pollution — are responsible for closing most of these waters to harvesting. *Coastwatch* staffer Jeannie Faris explains how and why these waters are closed through the experiences of a small New Hanover County tidal creek. Since the 1970s, Hewletts Creek has been sporadically opened and closed to shellfishing. The complex problems of this and other closed shellfish waters are not easily solved. 2

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Erosion is a natural process happening on virtually every beach; it demands a response only when it encroaches on manmade development such as houses, roads and bridges. In the clamor to protect property, many coastal communities are looking to beach nourishment — building up beaches with borrowed sand — to ease erosion woes. But as *Coastwatch* staffer Carla B. Burgess learned, it's an expensive, temporary remedy that's not without side effects. 19

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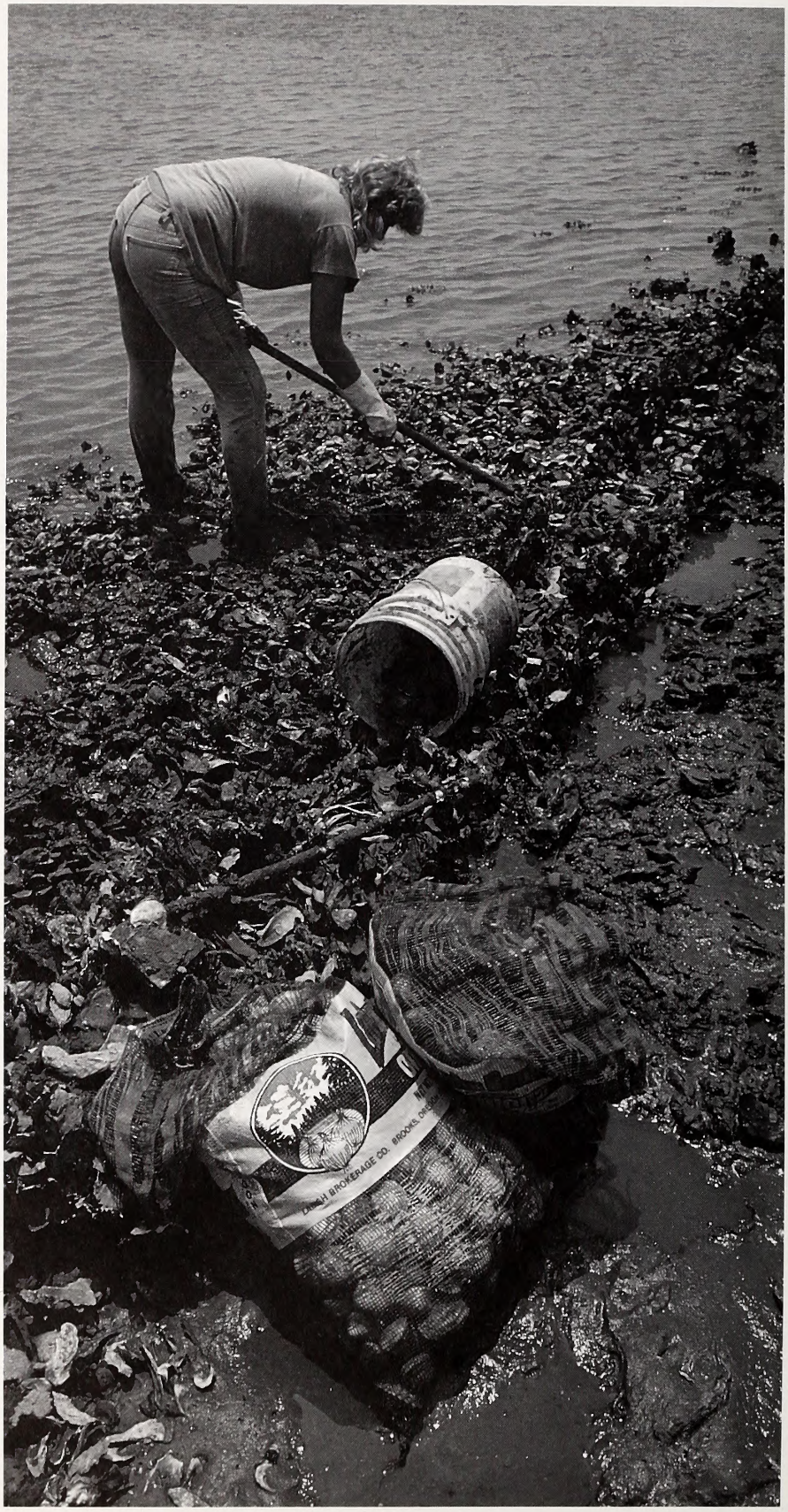

Scott D. Taylor

Productive shellfish areas are closed by a bacteria that is commonly washed in with nonpoint source pollution.

By Jeannie Faris

Keith Smalley has charted his life on Hewletts Creek. He grew up on its banks and its waters, the third generation of his family to live here. Now 32, he knows the creek's every blind turn through the marsh and saw grass.

He knows the trees — sweet gums, hickories and pines — that grow straight and tall on its banks. And he knows the treetop roost of an osprey that steers overhead on a westward wind. This is practically his back yard, where blue herons and egrets lift out of low marshy hideaways, kingfishers clip the tops of cattails and red-winged blackbirds sail in formation.

On a mid-fall afternoon, Smalley guides his johnboat through the sights of this small New Hanover County tidal creek, reminiscing about his years here. He motors to a remote circular clearing in the marsh he calls "the lollipop," only to find his old haunt bogged with plants.

"Things on the creek are changing," he says.

Perhaps more than he wants to admit.

The creek is changing under the weight of construction on its banks and its 2,415-acre watershed. Trees cut back from the creekside expose the edge of development that has been fueled in recent years by a new central sewer system and a stampede to build near the water.

Changes of this kind are hard to overlook. But the environmental strain on the creek's waters has been less evident.

Gradually, Hewletts Creek has been polluted by runoff and spills from a nearby sewage pump station that serves the beach area. Years of invisible abuse have slowly weakened the creek to the point that it is illegal to oyster or clam its entire length. The creek is closed from the narrow fingers that wind through head-high grass to the mouth where marsh fades to open water.

"I seldom see a fisherman out there anymore with the pollution signs up," says Dorothy Reid, Keith's grandmother and a 47-year resident of Hewletts Creek. "And I haven't eaten an oyster out of there in 10 years."

The green no-shellfishing signs near Reid's home are posted on creeks and sounds that fail to meet strict bacterial standards protecting oysters and clams for human consumption. But not all creeks are held to these standards — only shellfish areas, one of three designated uses that the state Division of Environmental Management (DEM) stamps on coastal waters.

Like other closed shellfish waters, Hewletts Creek has been found to exceed the bacterial standards through sampling by the Shellfish Sanitation Branch of the N.C. Division of Environmental Health.

Like other closed shellfish waters, Hewletts Creek has been found to exceed the bacterial standards through sampling by the Shellfish Sanitation Branch of the N.C. Division of Environmental Health. This information is passed on to the N.C. Division of Marine Fisheries (DMF), which closes the areas to harvesting. Months or even years may pass before sampling shows that closed areas are ready to reopen. Some shellfish waters around marinas are closed permanently to protect against illegal sewage discharges from boats. Other areas are closed for a few days or weeks by rain that washes bacteria into the water.

This information is passed on to the N.C. Division of Marine Fisheries (DMF), which closes the areas to harvesting.

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Weather patterns — wet or dry — usually drive this revolving door of openings and closings. This is expected. But weather alone doesn't account for shellfish waters that are closed to harvesting more often than opened.

Over the past 12 years, pollution has claimed an additional 6,600 acres of shellfish waters from Carteret County's Cedar Island to the South Carolina line in Brunswick County. About 43,500 acres in this region are off-limits to harvesters, a status known as prohibited. Add to that about 45,000 acres that are closed temporarily, and the area beyond the reach of shellfishermen more than doubles.

Richard Barber, a professor of biological oceanography at the Duke University Marine Laboratory, has searched for trends in shellfish openings and closings. He used data collected by Shellfish Sanitation to examine the 303,575 acres of productive shellfish waters between Cedar Island and the South Carolina line from 1980 to 1992.

The numbers bode poorly for North Carolina, Barber says.

At first glance, however, the trends might appear encouraging and even suggest that the state has been on the right track with its pollution management strategies, he says. In 1992, nearly 260,100 acres of shellfishing waters were open, compared to 259,700 acres in 1980. But this modest 400-acre net gain can be traced back to two large openings in 1983 and 1984 on the New and Cape Fear rivers. These one-time openings of about 7,000 acres were made possible by improvements in point source discharges from industry and wastewater treatment plants.

North Carolina cannot count on openings of this size again, Barber says.

Meanwhile, the region's other shellfish areas have been slowly eroded away by polluted runoff — called nonpoint source pollution — from development, septic tanks, marinas, agricultural operations and homeowners' lawns. An average of 550 acres each year are added to the list of closed waters, although the trend has been obscured by the two large openings, Barber says.

"The most recent losses are most rapid," he says.

Continued

The 1993 statistics are expected to bear this out. Losses will overtake the gains of the mid-1980s, and for the first time in a decade, the number of open shellfishing acres will drop below 1980 levels, Barber says.

The good news is that these closings won't have a tremendous impact on oyster lovers because North Carolina imports most of its shellfish from Louisiana and other states.

The bad news is that fishermen can't make a living off of the ever-shrinking shellfish areas. Disease and to a lesser extent pollution have trimmed harvests by half over the last decade. Oysters are down from 110,160 bushels in 1982 to 57,379 in 1992; clams decreased from 1.2 million pounds to 722,000 for the same period. Clam production, however, is still among the highest in the nation.

There may also be broader environmental implications. Shellfish areas are closed by fecal coliform, a harmless bacteria that is washed into the water and used by resource managers as an indicator of dangerous pathogens. The bacteria may

Scott D Taylor

Shellfish areas may look safe, but Shellfish Sanitation tests them to ensure that they're suitable for harvesting.

More than half of North Carolina's 2 million acres of coastal waters are suitable for shellfishing. The Shellfish Sanitation Branch of the N.C. Division of Environmental Health samples these waters and catalogs them in one of four ways. Following is a breakdown of the 303,575 acres of shellfishing waters between Cedar Island and the South Carolina line.

APPROVED

Shellfishing waters that are opened to harvesting; 260,100 acres.

This includes a subset of waters: Conditionally Approved

Shellfishing waters that are open but automatically closed after a certain period and amount of rain. Shellfish Sanitation is preparing management plans, due in April, that will state the circumstances (amount of rain, period of rainfall) that will close each area. The waters are reopened when sampling determines they are safe; 45,000 acres.

Also, shellfishing waters that are closed to harvesting but temporarily opened during dry spells if samples indicate safe levels of fecal coliform bacteria; 5,000 acres.

PROHIBITED

Waters that are entirely closed to shellfishing in one of three ways: by contamination of fecal coliform bacteria; by law, such

also be keeping company with nutrients, sediments and other pollutants, such as pesticides, trace metals and hydrocarbons, which are occasionally found in runoff.

On Hewletts Creek, the fecal coliform pollution is masked by thickly grassed waters that are the picture of estuarine health. But the row of no-shellfishing signs posted at the mouth tell a different story of a creek that has been closed on and off since 1974.

One unusual chapter of this story features a pump station that has spilled sewage into the creek twice since 1989. One spill, in July 1992, released 500,000 gallons into the creek. The pollution closed the entire creek and 6 miles of adjoining Masonboro Sound, which is designated a shellfishing area and "outstanding resource water" (ORW) in certain stretches. This ORW status guarantees the sound special protection that the creek doesn't have. Today, the sound is open again, but Hewletts Creek is not. Seven months after the July 1992 incident, it was polluted again by another sewage spill.

Continued

Scott D. Taylor

Green no-shellfishing signs flag troubled waters.

as when they surround a marina; or by the presence of a point source discharge from a wastewater treatment plant; 43,500 acres.

This includes a subset of waters: Restricted

Closed waters from which shellfish can be relayed to clean areas, usually in April and May, where they must remain a minimum of two weeks before they can be harvested; Acreage not available.

WATERWISE: CURBING RUNOFF

Now more than ever, we hear about nonpoint sources of pollution degrading our inland and coastal waters. But where does this pollution originate, and how can we protect our waters from it?

Sea Grant coastal water quality specialist Barbara Doll answers these questions in the fall 1993 issue of WaterWise. *"Curbing Nonpoint Source Pollution: North Carolina Waters at Risk" looks at these sources of pollution and the effect they can have on coastal waters. Doll also reviews North Carolina's plans to curb nonpoint source pollution through a new plan mandated by Congress.*

To order this free publication, write N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605. Or call 919/515-2454.

Watchful residents have monitored the pulse of the creek's health since the 1970s, when a package plant treated sewage nearby. Few details have escaped them.

Mona Smalley, Keith's mother and chairwoman of the Hewletts Creek Watershed Association, says crabs are fewer along the creek's mud flats and some have been sighted with shell diseases. Creek residents have been reluctant to sink their crab pots there.

Reid says she measures the changes by what she can no longer see. Back in the 1950s, shrimp were abundant enough to fill a bucket with a few passes of the push net. Push nets are no longer legal, and it's just as well, she says. The catch would be nil. More recently, sea urchins and small crabs have disappeared from the flats at low tide. Fishermen no longer make a living from the creek's marine life. And the family of otters that visited a few years ago is gone.

Scott D. Taylor

The condition of a shellfish area and its suitability for harvesting depend largely on the type of development nearby.

The quiet unraveling of Hewletts Creek is the price of excess, a landscape out of Rachel Carson's *The Sea Around Us*, Reid says.

"Rachel Carson's whole philosophy about how we're ruining our water, we're ruining our earth, that's how I feel," she says. "All of us who have lived here a long time, who have a deep affection for what's in our front yard, feel a tie to her.

"We say we've had the best of it. It's just going to get worse."

Keith Smalley doesn't have the years of perspective that have shaped his grandmother's vision of the creek. He sees more hope for its future. And judging by his days on the water, he says the creek looks ready to reopen to shellfishing. This, too, is the goal of the Hewletts Creek Watershed Association.

State regulators, however, are less certain.

Hewletts Creek still exceeds fecal coliform standards allowable for shellfishing. Shellfish Sanitation tests coastal waters for these bacteria, which originate in the intestines of warm-blooded animals and point to the possible presence of pathogens and bacteria that cause typhoid, hepatitis and the vomiting and diarrhea associated with gastroenteritis. People who eat raw shellfish that have ingested these pathogens can become ill.

Very low levels of fecal coliform are allowed in open shellfish waters, however. These waters are closed when the bacteria count exceeds 14 organisms per 100 milliliters of water, or about one-half cup. Before they can be considered for reopening, at least 15 samples must be taken, and no more than 10 percent of these samples can exceed 43 organisms per 100 milliliters.

Six samples collected in 1993 from the front of Hewletts Creek have failed the fecal coliform standards with a median count of 23 organisms per 100 milliliters, says Patricia Fowler, environmental health specialist for Shellfish Sanitation.

"Recent samples don't look good," she says. "They're mixed."

Shellfish Sanitation is also sampling the back stretch of Hewletts Creek — from its midpoint to the headwaters — where the sewage pump station is sited. These are prohibited waters, and median fecal coliform counts taken last year at two stations were 49 organisms per 100 milliliters and 56 organisms per 100 milliliters.

Obviously, the back stretch is an unlikely candidate for reopening. But the waters from the midpoint to the mouth of the creek could eventually be opened, says George Gilbert, assistant branch head of Shellfish Sanitation.

"In these small areas, especially small estuaries in fairly populated areas, a closure is not irreversible," Gilbert says. "But it's few and far between where they improve."

Still, interest in the creek is high among residents and DMF law enforcement officers if phone calls are a gauge, Fowler says. The area is being tested a minimum of five times a year. If the results were to improve, however, Shellfish Sanitation would sample more aggressively.

As a rule, more emphasis is given to

waters with high potential for clearing. Sampling is also stepped up for areas that are closed a few days following heavy rains. These waters are shut down because 2 or 3 inches of rain can wash high levels of bacteria and pathogens into the creeks.

On the other hand, during a dry period, Shellfish Sanitation will test especially productive waters in closed areas and open them for a short time. They are automatically closed again after one-half inch of rain.

"When time permits, we check as many sites as we can," Gilbert says. "The problem is it's usually dry everywhere. They're all calling, and we can only test so many sites. We try to alternate, pick an area with the most shellfish resource."

Hewletts Creek appears to have a steady, nonpoint supply of the bacteria that closes shellfish waters, and this is probably why it hasn't cleared enough to reopen, Gilbert says.

Jeannie Faris

Hewletts Creek resident Mona Smalley hopes the front portion of the creek can be reopened to shellfishing.

In other words, the problem is much broader than a single malfunctioning pump station. It starts miles inland at the far edge of the creek's watershed. Within this watershed boundary are two major malls and one of the fastest-growing areas in the county. In the immediate area of the creek, 22 developments have been built since 1987, adding 745 housing units on 479 acres.

"As development takes place, typically the creeks are closed to shellfishing," says Patrick Lowe, assistant director of New Hanover County's Planning Department. "That's not to say that development in and of itself is the only source. As development takes place, there are changes in the physical parameters along the creeks that lead to closures."

Hewletts Creek — and others like it — are big sinks for the pollution that is swept from urban and residential development, marinas, dump sites, septic systems, agricultural fields and animal operations. Statewide, these nonpoint sources account for about 63 percent of the closed acreage in estuarine waters, according to a DEM water quality report.

But nonpoint sources haven't always been the leading culprit. Before the growth boom in the 1980s, pollution sleuths traced most of the damage to point sources — treated, permitted discharges from municipal wastewater treatment plants or industries. These problems were remedied by better wastewater technology and tighter regulations.

And they were quickly replaced by nonpoint source pollution that sweeps along the heels of population growth and development. The growth was made possible, in part, by the same technological advances that choked off point source pollution.

"We grabbed the end of the pipe and squeezed it as hard as we could, and we made significant gains in improving water quality," says Doug Rader, senior scientist for the N.C. Environmental Defense Fund. "But while we were making gains in point sources, we were steadily losing ground because of nonpoint source pollution from a variety of sources."

The ground lost is hard to regain. Without careful planning, land that is disturbed or paved can become a runway for pollution. Runoff is no longer able to filter through vegetation that has been stripped away. Instead, it washes over asphalt, sidewalks, parking lots and rooftops, carrying fecal coliform and other pollutants. The destination of these slugs of runoff is the tidal creeks. The flow is greater because the water isn't absorbed by the ground before it arrives. And it carries silt that can fill the creek and choke off waters that previously flushed away pollutants.

"Under natural conditions, you get little runoff. But as you convert the land, it becomes worse," says Todd Miller, executive director of the N.C. Coastal Federation. "So basically, wherever there's activity on land — agriculture, forestry or urban — you're going to have

Continued

water quality problems."

This was the case on Howe Creek. Before it was closed by nonpoint pollution in December 1991, it had been the only New Hanover County tidal creek still open to shellfishing. One by one, all of the county's other creeks had been partially or entirely closed.

Residents, however, were blindsided by the closure because Howe Creek had been protected as a shellfishing area and an ORW. It was the only tidal creek in the county with this level of protection, meaning that it had exceptional water quality, no known point sources of pollution and a high resource value when it was designated in 1989.

As such, it has been protected from certain development since that time. Construction within 575 feet of the water must be low-density, covering no more than 25 percent of a lot. Increased buffer zones of vegetation are required, and no dredge or fill activities are allowed near significant shellfish areas.

But all to no avail. Howe Creek was closed even though recent development has met these ORW standards.

Follow-up investigations by DEM and Shellfish Sanitation have not yielded much information on specific sources of bacteria, says Beth McGee, an environmental supervisor in the water quality planning branch of DEM.

Because the pollution sources are mostly nonpoint, they're washed from a large land area and are very difficult to track. Also, the movement of fecal coliform bacteria into coastal water is still poorly understood.

But the Howe Creek closing flies in the face of the federal Clean Water Act, which says there should be no water quality degradation, especially in ORWs, says Derb Carter, an attorney with the Southern Environmental Law Center. ORWs account for about 198,000 acres of salt water in North Carolina.

Jeannie Faris

The beauty of Hewletts Creek belies the bacterial contamination that has closed it entirely to shellfishing.

"It is the most stringent classification and doesn't meet the basic anti-degradation policy to protect existing uses," Carter says.

The anti-degradation policy is part of the Clean Water Act, and it is the principal tool in protecting shellfish waters. It requires all states to designate their waters according to their uses as of November 1975 and then protect and maintain those uses.

"The whole notion of it is, we're not going to drop back from clean water to some medium ground between somewhat clean and polluted," Carter says. "We're going to do whatever we can not only to restore waters that are impaired but to maintain the clean waters that we have."

Shellfish closings are an extremely complex problem in all coastal states, McGee says. In North Carolina, DEM has a three-tiered system to protect these and other waters.

First, coastal salt waters are classified for three basic uses: commercial shellfishing, class SA; fishing and organized recreation, such as swimming, class SB; and infrequent swimming, boating, fish propagation and wildlife uses, class SC. These classifications are used to develop water quality standards, which in turn are used for point and nonpoint source control strategies.

On top of these uses, waters can be supplementally classified "high quality waters" (HQWs) and ORWs, which are given extra protection from certain discharges and stormwater runoff from nearby development. Shellfish waters, for instance, are automatically HQWs. Waters that qualify as ORWs must meet even stricter criteria than HQWs, and they're protected to a greater degree. But both help meet anti-degradation policies.

These classifications are the foundation of the state's effort to curb water pollution. From there, DEM has built a series of programs to control the elusive nonpoint sources, with varying degrees of success. Congress has also entered the picture with a new incentive for states to get their coastal act together.

When Congress reauthorized the

Coastal Zone Management Act in 1990, it gave coastal states an ultimatum: come up with a plan to protect the coast from nonpoint source pollution or risk losing federal money. Congress had concluded that these waters were not being protected by the existing programs of education, demonstration projects and voluntary application.

Stronger measures are needed to prevent degradation of coastal waters that support their uses and restore those that don't — the goals of the plan.

DEM and the N.C. Division of Coastal Management are in charge of drafting the plan by July 1995. And since DEM already has a strong statewide program that has met some of the elements of a coastal nonpoint plan, the agencies involved believe North Carolina is well poised to meet Congress's mandate. But some tailoring will be needed for certain nonpoint sources.

The state's first task is to launch across-the-board measures to control runoff from agriculture, urban and newly developing areas, forestry operations, marinas and hydromodification projects. Then, if these measures are inadequate, the state will identify where existing land uses are impairing waters and where expanding land uses are threatening to impair. These areas, usually adjacent to coastal waters, will be designated "critical coastal areas" if the management measures cannot adequately restore or protect them. The big hitters identified in this analysis will be subject to additional management measures.

The plan will be reviewed by EPA and the National Oceanic and Atmospheric Administration.

"It's very clear from the direction things are going ... there is a clear legal imperative and mandate to do much more than we are currently doing to address nonpoint source pollution and integrate it into the point source program," Carter says.

Jeannie Faris

Trees and grass grow tall over the narrow back reaches of Hewletts Creek.

But local involvement and grassroots activism cannot be left out of the formula. In fact, they're by far the most critical element, say Barber and McGee.

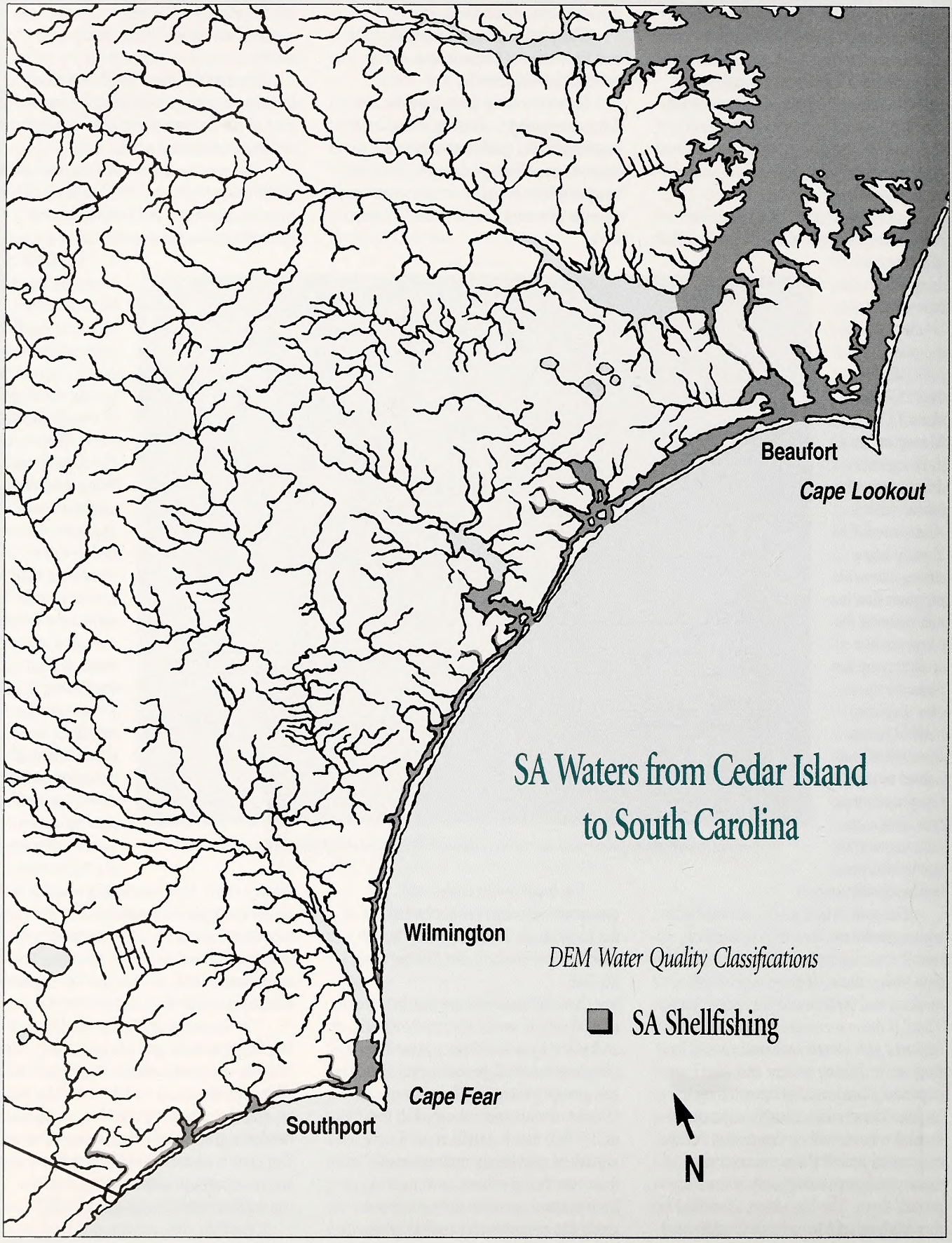
Special measures are needed to curb coastal runoff, and they cannot all be addressed by a broad state plan. This is the place for local governments and citizen groups to step in. New Hanover County, for instance, decided in the mid-1980s that it would control new growth in previously undevelopable areas that were being offered sewer services. So it created resource protection areas along the estuaries and sounds where development was limited to 2.5 units per acre and set back at least 75 feet from the marsh.

Meanwhile, New Hanover County land-use meetings were heightening awareness of the problems and rallying people to the cause of cleaner water.

"No agency alone can solve the closed shellfishing problem," McGee says. "There must be a great deal of local input and commitment to get anywhere."

Up-front commitment and local planning can open shellfish areas where residents cooperate to control the flow of runoff into the water. The Hewletts Creek Watershed Association is one example of how people have channeled their concerns into action and taken charge of the water at their back door. In recent years, members have tried to control pollution-loaded runoff by looking into their own yards and planting vegetative buffers there. The watchdog group has also worked to guarantee orderly growth in the area by speaking up when the county was updating its land-use plan, attending zoning meetings and challenging development plans that could drain into the creek.

"In the last couple of years, the area has really opened up," Mona Smalley says. "People want to be on the water. And with all the development and the declining water quality in the creek and the sound, we needed a group that would follow through. Our goal is clean water. We want to restore and maintain the water quality so that it can support shellfishing again."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New Hanover County's Watershed Watch

By Jeannie Faris

Pollution has partially or entirely closed the shellfishing waters in all of New Hanover County's estuarine creeks.

But how could this have happened? After all, the county is more progressive than most in its strategies for protecting these waters.

It was probably nonpoint pollution. The county is the second most urbanized in the state with 124,000 people living in a 185-square-mile area. And most of this growth has occurred between the Wilmington city limits and the coast.

But even this doesn't fully explain why some of the county's more rural creeks are closed to shellfishing. Futch and Howe creeks were shut down, and they're both in pristine areas of the county's sparse northern reaches.

After years of simmering, the issue has finally reached critical mass in New Hanover County, says Patrick Lowe, assistant director of the county's planning department. People want some answers.

Enter the county's new Estuarine Watershed Management Plan, a four-year effort to study water quality and plan for future growth.

In August, the county launched phase-one of the plan with a research agreement with the University of North Carolina at Wilmington Center for Marine Science Research to study fecal coliform and other pollutants in four major tidal creeks: Howe, Bradley, Pages and Hewletts. The university will also continue and incorporate the results of a study in progress on Futch Creek.

When the statistics are ready, New Hanover County will have some measure of the upcoming effects of urbanization on these creeks and plan for growth in their watersheds, Lowe says.

Jeannie Faris

Tests show bacteria levels are too high in the back portion of Hewletts Creek to be considered for reopening anytime soon. The front section, however, holds more promise. Hewletts Creek is one of the major tidal creeks in New Hanover County that will be monitored for pollutants by the University of North Carolina at Wilmington Center for Marine Science Research.

Futch Creek residents, however, were ahead of the county in their pursuit for answers. Organized as the Northeast New Hanover Conservancy, they raised money and contracted the water quality expertise of Ronald Sizemore, head of the UNC-W biology department. The report, finished in April, showed that the creek is only slightly polluted, with hot spots that probably can be tracked and plugged. The county will experiment with dye to trace leaking septic systems, with retention basins and with dredging to improve the creek's water quality.

The conservancy approached Sizemore for this work on the merit of his Sea Grant-funded research that makes molecular fingerprints of fecal material, which can be traced back to its origin. This technology is used extensively in medicine, he says, and its new application to environmental science is promising.

But Sizemore says he isn't certain whether he will continue using this advanced technology on the other creeks. The research for New Hanover County will be coordinated by Jim Merritt, director of the UNC-W Center for Marine Science Research, he says.

"This was such a success that we're trying to look at the other creeks in the system to provide a countywide water assessment," Sizemore says. "It's obvious that we can gather a valuable product that (the county and state) didn't have time to get on their own and turn it over to them so they can be better managers."

HOW THE Motion of the Ocean AFFECTS YOU

By Kathy Hart

Tony Tillett says he expects one out of six anglers who step aboard *The Carolinian* to experience it.

Sea Grant agent Bob Hines says the slow heave and roll of large oceangoing vessels drive him to it.

Hippocrates, Cicero, Admiral Lord Nelson, Charles Darwin and President Harry Truman all knew the malady.

And 10 to 15 million American adults are regularly susceptible to its misery.

Know what it is?

Seasickness, known more generally as motion sickness.

This bane of travel afflicts an estimated 90 percent of American adults sometime during their lives. It can happen on an offshore fishing charter, on a trans-Atlantic air flight, in the confines of the space shuttle Endeavour or in the backseat of your father's Oldsmobile. It torments young and old, men and women, astronauts, pilots and Navy sailors.

For North Carolina's charter fleet, seasickness is part of doing business. Tillett, who owns and operates an Oregon Inlet charter boat, says he expects a percentage of his clients will be stricken with mal de mer.

When the symptoms strike — dizziness, pallor, cold sweating, nausea and vomiting — Tillett recommends that the afflicted stay on deck in the fresh air and, if breakfast arises, avail themselves of the side of the boat instead of the toilet.

"The inclination is to go below and lie down," Tillett says. "That's the worse thing you can do."

Occasionally, Tillett brings a fishing party back to shore because one or two anglers are miserable, evoking concern and a call for the docks from the others.

But Alan Foreman says he can't be so accommodating. He captains a bottom-fishing head boat, *The Country Girl*, that takes 27 fishermen offshore to hook sea bass, triggerfish and grouper.

"There are a few people who get sick regardless of whether it's a rough day or the prettiest day you'll ever see," Foreman says. "And there are those who drink a lot of beer or liquor the night before and stay up late. They're going to be sick.

"But those who get a decent night's sleep and a good breakfast usually make it OK," he says.

For those who endure a day of motion misery, there is always relief ahead. "As soon as we're within sight of land or pass under the (Oregon Inlet) bridge, people just seem to start feeling better," Tillett says.

Some Ways to Avoid Motion Sickness

Eat a small, low-fat, starchy meal before traveling. If it is a long trip, munch on crackers along the way.

Look at the movement that your inner ear is sensing. On a boat, use the horizon as a reference to remind yourself that you are indeed rocking.

Stay busy with other thoughts. Subjects asked to solve mental problems get sick less frequently in motion sickness tests.

Don't worry. Anxiety can stimulate many of the same hormonal reactions that precipitate nausea.

Stay away from alcoholic beverages. Contrary to popular belief, alcohol affects inner ear function and can make a seasick person feel worse.

The History

Although associated with modern modes of travel, motion sickness has plagued humankind since the construction of the first vehicle, probably a waterborne raft or canoe.

The ancient Greeks provide the first written accounts of motion sickness. In fact, the word nausea derives from a Greek word "naus" for ship, and Hippocrates noted that "sailing on the sea proves that motion disorders the body."

Through the years, healers employed a variety of remedies to stop the body's response to motion. In the 12th century, the monks of Salerno prescribed a mixture of seawater and wine to protect against seasickness. Later that remedy was modified to wine and sage water. Sedatives and narcotics were also widely recommended by doctors. And British philosopher Sir Frances Bacon noted in the 1600s that a bag of saffron carried next to the stomach relieved mal de mer.

To reduce jostling of the stomach, which some 19th-century doctors believed

initiated seasickness, a "hypogastric belt" was devised. More shocking was a device that placed a pad against the stomach and another against the small of the back. When an individual began to feel ill, a mild electrical current was passed between the pads and through the body.

Some doctors prescribed special diets for those about to embark on the high seas. These ranged from austere pickings such as dry toast, gruel and sago to exotic feasts. One remedy called for a soup made of horseradish and rice, seasoned with red herrings and sardines. Pickled onions were viewed by one doctor as a preventive; lemon juice and pickles, another physician's cure. Perhaps doctors theorized that once you consumed these less appealing foods, you would fight like the devil to keep from seeing them again.

THIS BANE OF TRAVEL AFFLICTS AN ESTIMATED 90 PERCENT OF AMERICAN ADULTS SOMETIME DURING THEIR LIVES. IT CAN HAPPEN ON AN OFFSHORE FISHING CHARTER, ON A TRANS-ATLANTIC AIR FLIGHT, IN THE CONFINES OF THE SPACE SHUTTLE ENDEAVOUR OR IN THE BACKSEAT OF YOUR FATHER'S OLDSMOBILE. IT TORMENTS YOUNG AND OLD, MEN AND WOMEN, ASTRONAUTS, PILOTS AND NAVY SAILORS.

Although most people view motion sickness as a curse, healers of centuries past credited it with therapeutic powers for consumption, insanity, dropsy, tumors, apoplexy and other diseases. Nineteenth-century psychiatrists rotated patients to induce sickness, believing that the rapid spinning increased blood supply to the head.

And the Germans used motion sickness as a means of punishment for delinquent youths. A small sentry box was suspended on pivots, and an offender was placed in the box and spun until he or she retched, often before a crowd of onlookers.

The Causes

Just as the remedies for motion sickness varied from the mundane to the bizarre, the theories for its causes have also run a gamut.

Some doctors believed that motion disturbed the normal functioning of the stomach. Others thought the nervous

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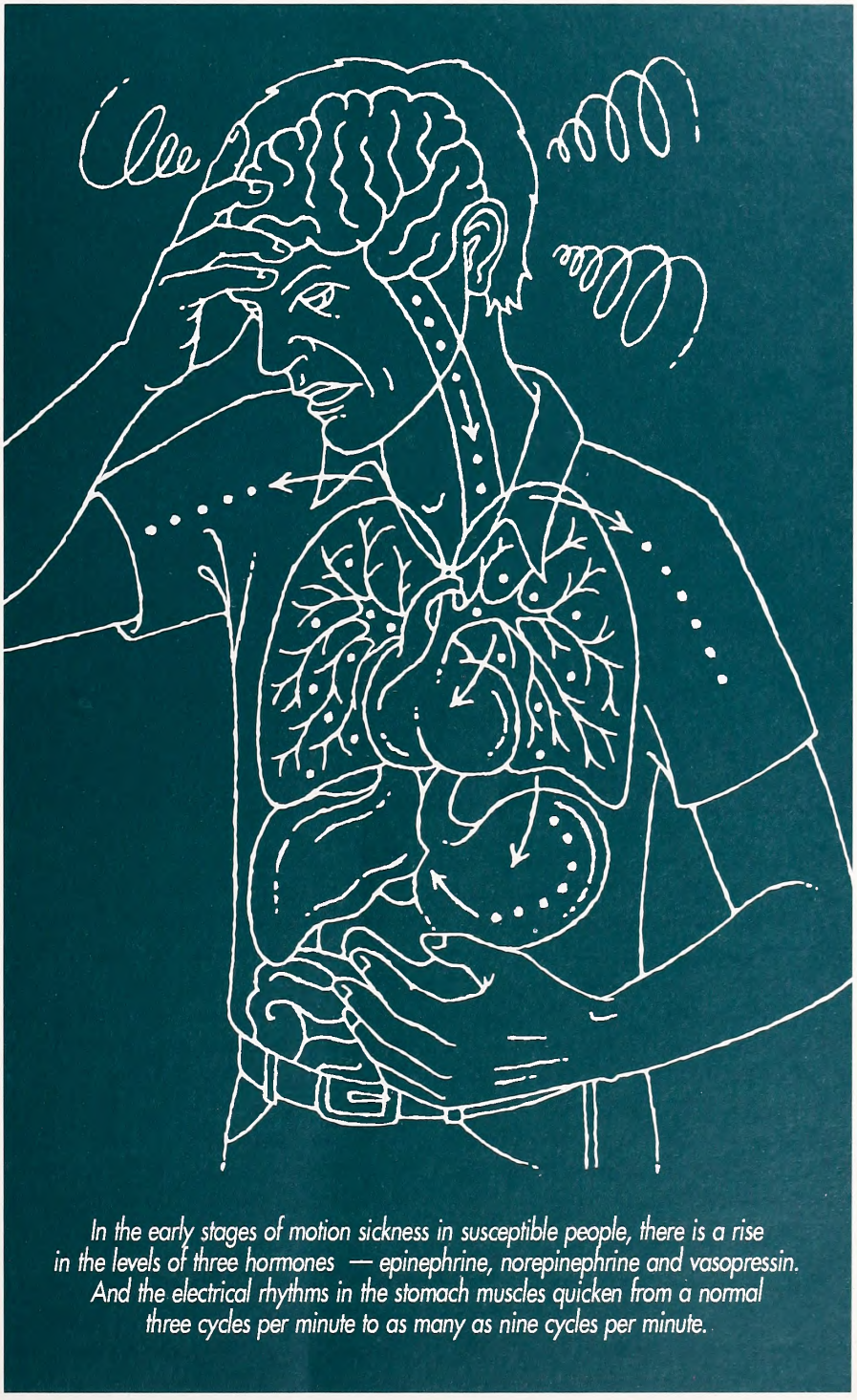


In the early stages of motion sickness in susceptible people, there is a rise in the levels of three hormones — epinephrine, norepinephrine and vasopressin. And the electrical rhythms in the stomach muscles quicken from a normal three cycles per minute to as many as nine cycles per minute.

system was at the root of the problem. A lack of circulation of blood to the brain was once blamed for motion sickness. And in the late 1800s, researchers began to suspect the inner ear played a role in causing the malady.

Today, scientists say a neurosensory mismatch in the brain causes motion sickness, says Dr. Kenneth Koch, a gastroenterologist who has studied the syndrome at the Hershey Medical Center in Pennsylvania.

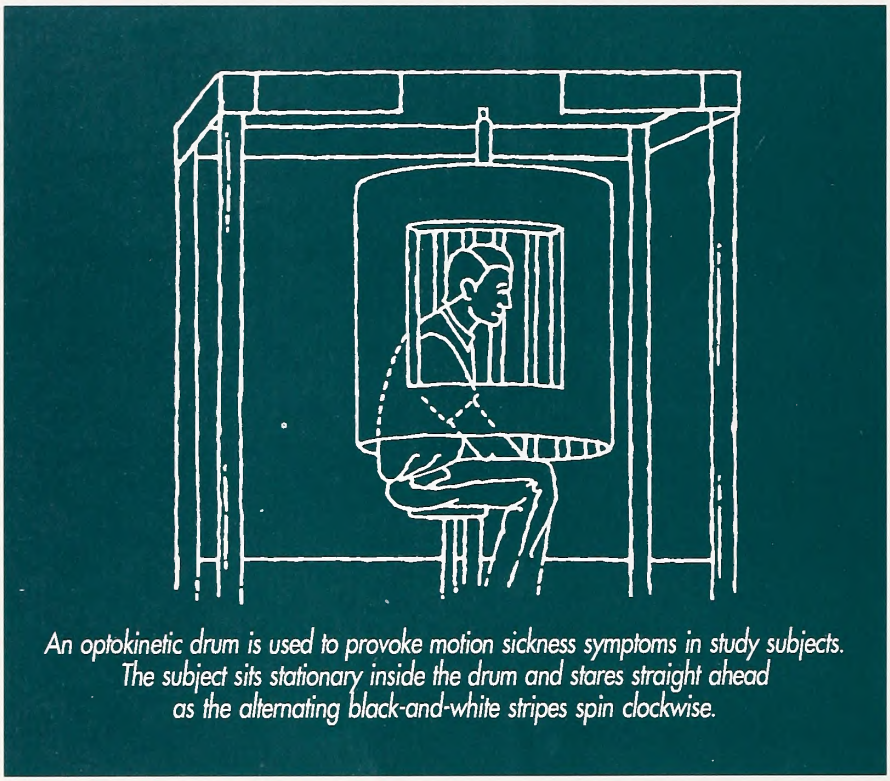
It involves three systems — the eyes, the inner ear and sensory receptors called proprioceptors. When these systems are in sync, all is well.

But put a person in the cabin of a rocking boat and the cues become mismatched. The inner ear detects the boat rocking, and the proprioceptors in the soles of the feet sense it too. But since the cabin moves with the passenger, the eyes don't see the motion.

Similarly, a child in the backseat of a car sees motion as objects flash by the window, and his or her inner ear senses it. But because the child's body moves with the car, the proprioceptors in the body don't feel the movement. These sensory mismatches begin the process of motion sickness.

To study motion sickness in the laboratory, Koch places subjects inside a large rotating vertical drum that creates the illusion of motion. A study subject sits on a stool inside the drum, which has black-and-white vertical stripes painted inside.

The drum rotates clockwise around the individual about 10 times per minute.



An optokinetic drum is used to provoke motion sickness symptoms in study subjects. The subject sits stationary inside the drum and stares straight ahead as the alternating black-and-white stripes spin clockwise.

Within seconds, the individual is visually fooled into believing that he or she is moving and not the drum. But the inner ear and proprioceptors are signaling the brain that the body is still. According to Koch, this sensory conflict provokes motion sickness in approximately 60 percent of the healthy people tested.

The Symptoms

Causes of motion sickness aside, Koch is also interested in what happens between initial dizziness and the need to heave.

To determine an individual's response during his experiments, Koch measures the electrical rhythms in the stomach and the hormones that affect the nervous system. He also asks the subject to record his or her feelings.

Soon after the drum begins to spin, Koch's instruments can determine who will be sick and who will not before the first waves of nausea roll over the study subjects.

One sign of the trouble to come occurs when electrical rhythms in the stomach muscles change, a condition called gastric dysrhythmia. Normally, three impulses of electricity pass from the top of the stomach down to the small intestine each minute. But in people experiencing motion sickness, the rhythms "go bonkers," increasing to as many as nine cycles per minute, Koch says.

SOME DOCTORS BELIEVED THAT MOTION DISTURBED THE NORMAL FUNCTIONING OF THE STOMACH. OTHERS THOUGHT THE NERVOUS SYSTEM WAS AT THE ROOT OF THE PROBLEM. A LACK OF CIRCULATION OF BLOOD TO THE BRAIN WAS ONCE BLAMED FOR MOTION SICKNESS. AND IN THE LATE 1800S, RESEARCHERS BEGAN TO SUSPECT THE INNER EAR PLAYED A ROLE IN CAUSING THE MALADY.

Interestingly, pregnant women who experience nausea during their first trimester also show increased electrical rhythms in the stomach when tested.

In addition to gastric dysrhythmia, the body's nervous system increases its secretions of stress hormones epinephrine and norepinephrine. And soon after, levels of another hormone, vasopressin, skyrocket in the blood. Vasopressin is associated with nausea and vomiting in other instances and other animals.

As all of these factors act on the body,

it ultimately says "enough is enough." The stomach convulses vigorously, forcing its contents upward. Then it's time to run for, reach for or hug the nearest receptacle.

In contrast, people unaffected by motion in the studies showed no changes in gastric electrical rhythms or in levels of hormones.

Susceptibility

Susceptibility to motion sickness varies. Women and children tend to be more sensitive to motion than men, Koch says. But no one knows why.

Chinese and people of Chinese descent are much more prone to motion sickness. They react more quickly to sensory conflicts and with more severe symptoms. Scientists believe Chinese susceptibility is related to an especially sensitive neurotransmitter system in their brain.

Are some people then immune to this misery?

No, says Koch. It just takes "more of whatever it is" that triggers the response in susceptible people to initiate it in those less affected by motion.

Case in point: It's estimated that the incidence of motion sickness among passengers on trans-Atlantic ships during moderate turbulence is 25 to 30 percent. But if conditions worsen to severe, as many as 90 percent of the passengers succumb to the symptoms of motion sickness.

Despite recent research, scientists have much more to learn about this motion-driven affliction. Although medical researchers better understand the body's response to motion, they are still unsure exactly which responses or combination of responses actually trigger nausea and vomiting.

Determining the exact factors could help medical researchers and pharmaceutical companies develop better anti-nausea drugs. Koch believes a drug that blocks gastric dysrhythmia or hormone activity, particularly vasopressin, might be a possibility for relieving the symptoms of motion sickness in the future.

Researchers also hope that an anti-nausea drug developed for motion sickness will have applicability for pregnant women and chemotherapy patients who experience nausea.

Present Treatments

Although not life threatening, motion sickness can be debilitating for astronauts, military personnel and pilots, affecting their job performance. NASA reports that 50 to 60 percent of its astronauts experience motion sickness during space missions.

IF ALL ELSE FAILS TO ALLEVIATE THE WAVES OF NAUSEA GRABBING AT YOUR GUT, TAKE HEART. YOUR BODY WILL ADAPT TO THE SENSORY MISCUES WITHIN A FEW DAYS TO A WEEK. YOUR BRAIN EVENTUALLY TAKES CHARGE OF THESE CONFLICTING MESSAGES AND CHOOSES TO BELIEVE ONE SENSORY ORGAN OR ANOTHER.

And for you and me, motion sickness can go a long way toward ruining a vacation, a fishing trip or the ride to grandma's house.

For now, the drugs and therapies that are available to combat motion sickness work well for some, but not at all for others. And many of the drugs, over-the-counter and prescription, can cause drowsiness, dizziness, blurred vision, nausea and vomiting — the very symptoms people seek to relieve.

As a first choice among over-the-counter medications, Koch recommends Marezine because it doesn't cause drowsiness. As a second choice, the doctor says select the popular Dramamine. It does, however, cause sleepiness in some people.

If neither of these drugs offer a solution, seek help from a physician, Koch says. Ask for a prescription of scopolamine, which is usually provided in the form of a patch that is placed behind the ear. The patch slowly releases the drug through the skin and into the bloodstream.

Then there's the herbal approach. *The Lancet* medical journal reports that capsules of powdered gingerroot curb motion sickness better, in some cases, than over-the-counter anti-nausea drugs. Powdered ginger is available in health food stores.

And for an ancient solution to an age-old problem, why not try acupressure? Several companies market wrist bands with hardened lumps woven into them that are designed to apply pressure to an acupressure location on the wrists called the Neiguan point.

Although some fishermen and boaters swear by these bands, doctors, including Koch, question their usefulness. However, Koch's skepticism about the bands didn't stop him and two other medical researchers from testing an acustimulation device that provides a mild electrical current to the Neiguan point.

Koch learned that the incidence and severity of motion sickness was lower in people who received a mild continuous current to the Neiguan point than in individuals hooked to bogus devices. A patent has been issued for a battery-operated acustimulation device that Koch says may soon be available through physicians.

In other research, Koch and Dr. Robert Stern, a psychophysiologist at Pennsylvania State University, proved that eating food can alleviate motion sickness symptoms. In an experiment, people who ate breakfast and those who had not were subjected to the rotating drum. Those with full tummies showed fewer signs of gastric dysrhythmia and motion sickness than those who fasted.

If all else fails to alleviate the waves of nausea grabbing at your gut, take heart. Your body will adapt to the sensory miscues within a few days to a week. Your brain eventually takes charge of these conflicting messages and chooses to believe one sensory organ or another.

A Gift from the Harbor

By Carla B. Burgess

When the U.S. Army Corps of Engineers offered the people of Atlantic Beach about 5 million cubic yards of free sand, who were they to look a gift horse in the mouth? The Morehead City harbor needed deepening and a nearby dredge disposal island would soon be filled up. The corps needed to get rid of the sand, and the town didn't mind having it.

True, the annual rate of erosion along this portion of Bogue Banks is below the state average of 2 to 3 feet per year. But with an estimated 90 percent of U.S. shorelines characterized as eroding, how could an additional buffer of storm protection and a wider beach hurt?

The project began in mid-October, over eleventh-hour objections by the N.C. Marine Fisheries Commission. Local fishermen were alarmed by a university researcher's warning that the material piled onto the intertidal beach would bury mole crabs and coquina clams, which are food for such commercial and recreational species as pompano, sea mullet and juvenile flounder. The commission asked that the project be delayed until December to lessen the impact on fall fishing and to keep from interfering with a study it was conducting on the impacts of commercial stop-net mullet fishing on recreational catches.

But with the contracts let with private dredging companies and the mechanical equipment set to begin, the cost of postponing the project would have exceeded $190,000 a day, says Atlantic Beach Town Planner Bruce Payne. The corps had a small window of opportunity in which to work, says Payne, having to dance around fall fishing season and still be done before spring turtle nesting and tourist season. And regardless of the timing, Payne says the benefits of the beach fill — which would have cost the town about $20 million to initiate on its own — outweighed any cost to fishermen.

Scott D. Taylor

Dredge spoil disposal setup at The Circle.

After all, the southern coastal communities of Wrightsville and Carolina beaches must spend millions of dollars every few years for ongoing beach nourishment. Beach nourishment — often called renourishment because of its required commitment to follow-up maintenance — is a process in which compatible material such as sand from navigational channels or inland or offshore sources is used to rebuild a beach.

Beach nourishment is preferred over hard protective structures such as sea walls, which protect property at the expense of the beach face, and groins and jetties, structures built perpendicular to the shoreline that trap sand but interfere with the supply of sediment to downdrift beaches. But beach nourishment costs millions in local, state and federal tax dollars, and it is a short-lived treatment for erosion, not a cure (see story, page 19). Still, it appears to be a more environmentally sound way to keep erosion at bay.

Whether or not a community pursues and pays for a beach nourishment project or gets a windfall of sand through dredging activities, there are tradeoffs. It is important to note that although nourishment and disposal both supply a beach, they must be evaluated by different criteria.

Beach nourishment is carefully planned and implemented as a 50-year project, requiring intervals of renourishment every two to four years. Dredging is a regular part of inlet and navigational

maintenance up and down the East Coast; material is disposed of on estuarine spoil islands, offshore dump sites or, when appropriate, on beaches. When dredged sediment is destined for beaches, the activity is arguably less discriminating than beach nourishment. There is often less control over timing, compatibility of sediment and the place where material is dumped.

"When we have a disposal operation, we don't really provide a lot of control; the quality of the material is relatively fine," says Tom Jarrett, chief of the Coastal Engineering Branch of the Corps of Engineers' Wilmington District. "We're not really trying to control or build a certain beach fill. In beach nourishment, we're actually trying to build a certain profile."

Even though many biologists agree that the burial of intertidal organisms is devastating, recovery appears to occur within a few months; these creatures are adapted to a harsh environment subject to extreme weather and conditions. The alternative, piling dredge spoil on potentially more productive offshore areas, has drawbacks too.

"The point is the timing of the activity could be adjusted so that people could have both the renourishment and have substantial recovery of organisms," says Charles Peterson, a researcher with the University of North Carolina at Chapel Hill Institute of Marine Science.

But there are other potentially harmful impacts — such as increased water turbidity that clogs the gills of filter-feeding animals — whose long-term effects are unclear.

Scott D. Taylor

The intertidal zone at Atlantic Beach.

"Maybe some of the criticisms that have been leveled here are not unfounded," says Payne. "I do have concerns about what it does to fish populations here. But you have to make a decision on one thing outweighing something else. It's going to be an enormous loss if some of these houses start falling into the ocean.

"It's a municipality's job to protect property," he says. "You can fall back, or you can add beach, in our case, adding beach at no cost. It doesn't take a genius to say, 'I think this is what we'll do today.'"

N.C. Sea Grant coastal engineer Spencer Rogers says accepting relatively compatible sand is usually not a bad idea.

"Erosion is a normal process on most beaches, and if there are acceptable sand supplies available for whatever reason, at low cost or no cost, then I think in many cases it's a good idea to put it back on the beach," says Rogers. "In most cases, the sand was lost from the beach originally."

But some experts are wary of projects such as the one at Atlantic Beach. It's an issue of quantity versus quality, says the director of the Laboratory for Coastal Research at the University of Maryland.

"One thing to consider is that Atlantic Beach really doesn't have that much of an erosion problem," says Stephen Leatherman. "With all the erosion problems you have in North Carolina, I guess they (beach communities) always think it's great to have more sand. But you should always look for good quality sand."

Leatherman says that Atlantic Beach should have asked the corps to pay for some follow-up monitoring of the project.

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"The corps would have monitored it if they (the town) had demanded it," he says. "They should know where the sand is going to, how turbid the water is."

Most parties — including the corps — agree that the material being placed on Atlantic Beach contains more silt and is not as coarse as might be desired for a nourishment project, resulting in more displacement and turbidity. It's also a larger disposal project area than has been typical along the state's coast. The material is actually coming from two sources — the harbor deepening and Brant Island, a dredge disposal site that is being emptied. And there have been some surprises, such as the large pieces of plastic liner from the spoil island that were spewed onto the beach and into the water during the early stages of the project. Also, the amount of available sediment was overestimated; there will actually be about 2.5 million cubic yards of material on the beach by the projected completion date of mid-February or March. Payne says original projections had included nourishment for 3 miles of Pine Knoll Shores. The fill will probably fall short.

A project in 1986 to dispose of almost 4 million cubic yards of dredged sediment on a stretch between Fort Macon State Park and the recreational area known as The Circle at Atlantic Beach also had some undesirable results. The sediment widened the beach to 250 feet in places, virtually landlocking the community's three public fishing piers.

"You could walk out to the water and look back on the end of the pier," says Sportman's Pier owner David Bradley, who says he suffered a substantial loss of income the next three years. Even though this year's disposal is taking place west of the piers, the surrounding turbid water kept some customers away during the close of the pier's season in November.

"When the waves break, instead of the white foam, it looks chocolatelike," Bradley says.

Payne says the negative impact on the fishing piers was unfortunate and led the town to specify placement of this new material westward, from The Circle toward Pine Knoll Shores. Also, the 1986 sediment contained a lot of clay and mudballs and a high shell content. But there was a proverbial silver lining, says Payne.

Scott D. Taylor

Pipes feed a slurry to Bogue Banks.

"The upside was that the material was more resistant to wind erosion. It also seemed to be very condusive to the growth of beach grasses," he says. In addition, a local group added sand fencing along the length of the project area, which helped establish dunes.

"The feeling was very positive," says Payne. It was that satisfaction that buoyed the town when a repeat offer came along.

"Atlantic Beach saw an opportunity that they thought wouldn't cost them anything," says N.C. Sea Grant Director B.J. Copeland. "And it may not if they're lucky. The bad news is that when their income goes down from people who may have been fishing there, this may hurt."

Copeland, whose background is in estuarine ecology, says the effects of dredged sediment disposal should be carefully considered.

"The Corps of Engineers aren't the culprits here," says Copeland. "They're being hired by a sponsor, the Ports Authority, which wants to have its harbor deepened. Atlantic Beach was a partner too, whether they knew that or not. They could've said, in return for us letting you put your spoil out here, you're going to have to monitor its impact because the beach and the fishing are real important to us, and we aren't going to let this happen unless we also understand what is happening. Then perhaps we would learn something."

Payne agrees that it would be good to have some data on this project, but says the stabilized beach was triumph enough.

"We essentially trusted whatever the corps said," he says. "Had we had problems with dying turtles on the beach and fish kills, then that would be another thing."

He added that the project appeared to have only a "temporary effect on the amount of fish that came in close to shore."

Even in the face of gloomy fisheries projections, the obligation to protect property is a clear priority, says Payne.

"Should we abandon beach nourishment because of concern for a year or two of beach fishing ... or some mole crabs?" he says. "Just to walk away from it as an option is simply not practical."

Living on Borrowed Sand

By Carla B. Burgess

When you're at the beach, it's hard to imagine a sand deficit. It seems to be everywhere. It sears your bare feet in the noonday sun, molds to your backside beneath your towel, blows into ears and eyelashes, and sticks to sheets and sleeping bags. But nature supplies these pearly grains sparingly. Nudged by the waves, sand oscillates gently between dunes and offshore sandbars, sloping and shaping the beach in a protective equilibrium. It also drifts alongside the shoreline in the parallel longshore current.

Sand is becoming a precious commodity on many beaches, as the advancing ocean nips at shoreline development in the natural process called erosion. Caused by seasonal fluctuations and extreme storms such as hurricanes and northeasters, erosion is only a problem when it menaces manmade structures. Other factors, such as the migration of tidal inlets coupled with coastal construction and the accompanying removal of sand from the system, also contribute to chronic erosion. A gradual rise in sea level — as much as 6 inches in the past century — is also heightening wave activity on the coastline. Over time, the beach will adapt by redistributing sand from the dunes to deeper water, accelerating shoreline retreat.

To protect their property, many coastal communities are turning to a practice called beach nourishment to ease erosion woes. In nourishment, the beach is replenished and reshaped using suitably similar sand from somewhere else, such as a navigational channel or offshore sand pit. The objective is an additional buffer of storm protection for oceanfront buildings and a wider recreational beach. But that recreational area wasn't always afforded such a premium.

Michael Halminski

Outer Banks real estate.

"The initial efforts in erosion control were not to protect the beach, but to protect the development, the houses and the people behind it," says Spencer Rogers, N.C. Sea Grant's coastal engineer. "Nobody was particularly concerned about the beach."

Until, eventually, it began to disappear.

In the late 1800s, some coastal communities began using hard structures such as seawalls, groins and jetties to protect property and fight erosion. This armoring of the shoreline became more widespread with the post-1960s coastal development boom. Seawalls have succeeded in protecting landward property. But in the face of chronic erosion, these inflexible structures cause the beach to disappear and can adversely impact adjacent property. Groins and jetties, walled structures built perpendicular to the shoreline, trap sediment for the immediate beachfront but interrupt the natural sand flow to surrounding shores. North Carolina banned the use of hardened structures on its coast in 1984.

"We've learned by practice that if we spend enough money, we can build grand structures to protect the development, but what impact does that have on why we're there?" says Rogers. "In many cases, the use of the beach is a critical part of why we go to those coastal resorts. If there's no beach, there's no resort and there's no economy.

"If the beaches are disappearing and if buildings are being threatened, then replenishing beaches is one option that can protect both," he says. "Beach nourishment always keeps the beach, which is a

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prime requirement of coastal development, and it has little or no effect on adjacent properties. What impacts it does have are generally beneficial, since the neighbors end up with an incoming supply of sand from the longshore transport system."

The hitch?

It's expensive. In the United States alone, more than 400 miles of coastline have been replenished at a cost of about $8 billion, cites an article in the *Journal of Coastal Research.* Beach nourishment is high-maintenance, usually requiring a 50-year commitment by a community. And it's not a cure for erosion.

For many advocates of replenishment, Miami Beach, Fla., is a monument to how nourishment can be a prudent and successful coastal management tool if the benefits outweigh the costs. A 10.5-mile nourishment project in Miami, whose initial restoration was completed in 1982, cost $54.5 million.

"They took an area that had little or no beach, and not only did it provide the beach for the tourist industry, but because the project was publicly supported, it demanded that there be much more public access than there ever had been," says Rogers. "Street ends were opened up; parking lots were established. The entire beach has basically been turned into a public park."

Because replenishment is funded primarily with tax dollars, communities with higher density development and plentiful public access are favored candidates. Obviously, beachfront property owners stand much to gain from nourishment. But access ensures that taxpayers with inland berths can reap their investment too — whether that means a chance to birdwatch, fish, surf, swim or sunbathe. Proponents also point out that coastal tourism dollars boost the state's economy.

Nourishment projects, which are designed and built by the U.S. Army Corps of Engineers, are funded through federal, state and local cost-sharing. The split is 65 percent federal and 35 percent nonfederal, says John Sutherland, chief of the N.C. Division of Water Resources planning section. The state can provide up to 75 percent of the nonfederal portion, with the remaining cost assumed by local government, he says.

Michael Halminski

Room with a view.

In the case of neighboring Wrightsville and Carolina beaches, the only two ongoing beach nourishment projects in North Carolina, that local share is heavily supplemented by New Hanover County's hotel and motel occupancy tax.

"It works out such that basically the people who come to visit with us and use our beach strand the most actually pay for it," says Wrightsville Beach Town Manager Tony Caudle.

This is a convenient solution to recoup the local cost. But many argue that noncoastal residents, who pay their share in state and federal taxes, are unfairly burdened with beach upkeep.

"Although the local communities have shared the costs, a large part comes from the Corps of Engineers to protect the interests of a relatively small group of people," says Michael Orbach, a Duke University anthropologist who studies coastal issues.

The total price tag for Wrightsville Beach and Carolina Beach so far has been just under $24 million to nourish about 5 miles of beach over a 30-year period, says Tom Jarrett, chief of the Coastal Engineering Branch of the corps' Wilmington District. The tab for the Wrightsville Beach project, which began in 1964, comes to about $7 million, or $13.8 million when adjusted for inflation. Actual costs for Carolina Beach, begun in 1965, total $16.9 million; today's dollars inflate the figures to $30.4 million.

Meanwhile, other sand-starved coastal communities are lining up for nourishment. Other sites under study by the state and the corps include Kure Beach, Ocean Isle and the Dare County beaches. Initial restoration along 10 miles of beach at Nags Head, Kill Devil Hills and Kitty Hawk would cost $32.5 million, according to preliminary estimates by the corps. Renourishment at four-year intervals during the 50-year project would cost about $4 million each. Figuring in inflation, the project would average about $7.5 million a year. The corps is awaiting the go-ahead to delve into a more thorough feasibility study for Dare County beach-building.

The inescapable long-term commitment to nourishment can douse dreams the sandman may have induced in many beach communities, particularly smaller ones.

When the corps concluded a decade of

study on nourishment at Topsail Beach, the community couldn't ante up. With initial construction estimates of $13 million to $14 million, the town's share would have ranged between $1.5 million and $5 million, depending on how much of the tab the state picked up, says Town Manager Eric Peterson.

"Our annual operating budget for the town is just $1 million," he says. "We couldn't afford to do the renourishments after that."

The town of Long Beach made similar decisions, as will undoubtedly many small communities exploring the replenishment option.

Beach nourishment has other impediments besides cost, not the least of which is the difficulty in finding sources of high-quality sand; the farther away the sources, the higher the costs of getting it to the beach. Its high profile in the public policy arena has left it open to other criticisms. Some argue that by shoring up vulnerable property through beach nourishment, the government is abetting new development and rehabilitation of damaged property. Some contend that these blankets of shuttled sand are giving coastal residents a false sense of security and discouraging responsible building.

East Carolina University geologist Stan Riggs calls beach nourishment, at best, a "better-than-nothing" approach.

"What I see happening is that a lot of people and state agencies are using this as the answer, rather than dealing with the real problem," he says. "We continue to allow unlimited development. It would be better to get on with planning for the long term."

For Riggs and others, long-term planning may include a gradual retreat from the shoreline, whether this means stricter setbacks for new construction or relocation of existing ones.

"All of a sudden, it (beach nourishment) has become a magic solution," says Riggs. "Yet we know very little about the sources and very little about its impacts."

Overzealousness about the miracle of replenishment has caused what many perceive as irrational behavior in coastal management. A precarious erosion hot spot and a panic over how to protect it has produced a controversial conundrum at the Canadian Hole. This shallow estuary in the crook of Cape Hatteras will soon be doing duty to the oceanfront, surrendering the equivalent of 20,000 dumptrucks full of sediment to nourish the beach at Buxton. In the wake of Hurricane Emily, the N.C. Department of Transportation requested an emergency permit from the Corps of Engineers to dredge the sound and place the material between the ocean and N.C. 12, the Outer Banks' only thoroughfare.

Scott D. Taylor

Spreading sand on Bogue Banks.

Rogers and others have noted that it is storm surge overwash from the sound — which has been previously dredged — that threatens the stability of the road, not the ocean. Deepening the Canadian Hole further will only increase the chances that a new inlet will open. Buxton is a classic example of imprudent beach nourishment, says Rogers, pointing to the beach's chronic losses from erosion.

"We need more intelligent control of beach management practices," says JoAnn Burkholder, a N.C. State University botanist who chairs the N.C. Marine Fisheries Commission's habitat committee. The project, which will drop the depths of Canadian Hole an average of 13.5 feet, threatens more than 6 acres of prime estuarine sea grass beds.

"I don't know of any sea grass that'll grow 30 feet down in the mud," she says.

Further, the fine-grained material borrowed from Canadian Hole will whisk away as certainly as it has in the past, says Burkholder. "Even a short-term gain is questionable," she says.

The U.S. Fish and Wildlife Service also opposes the project based on the potential damage to estuarine resources. There may be tourism impacts as well.

"We may be making tradeoffs we may not realize," says Orbach of the dredging at Canadian Hole, a magnet for windsurfers from all over, particularly Canada. "Part of the reason it's popular is that it's shallow. We're changing the whole hydrology and wave patterns and configurations."

The corps has issued permits for the project, which was also contested by the National Marine Fisheries Service. Orbach dubs this policy a "dangerous

Continued

precedent."

"I don't think that anybody's trying to be insensitive to the needs of coastal property owners," he says. "What we need to make sure in our public policy is that all of the costs and benefits are put into the equation."

The questions of who pays and who gains will be at the forefront of the beach nourishment debate as development pressures and coastal populations swell. As sewer, water and other public works projects compete for funding, replenishment will need to prove its worth.

"There is no way we have the resources to pay to replenish all our beaches, and they're all basically eroding," says Riggs.

The National Academy of Sciences has appointed a committee to evaluate, among other issues, whether beach nourishment lives up to its claims. No one disputes that beach nourishment is inherently a sacrificial enterprise; it's not like anyone expects that the new sand won't eventually wash away.

"There are clear benefits of a project, even as it disappears," says Rogers.

But there is much contention about whether post-monitoring of projects is up to par.

"The most critical point is that there has been very little followup of very expensive nourishment projects," says John Wells, director of the University of North Carolina at Chapel Hill Institute of Marine Science. "The projected lifespan for virtually every project exceeds the lifespan of the project."

Early crude attempts at beach nourishment in the United States date back to 1922, when sand dredged from New York Harbor was dumped onto less than a mile of beach at Coney Island. By the middle of this century, beach nourishment became more refined, based on sophisticated engineering and scientific models.

"When we nourish a beach now, we know you can't simply nourish the upper part of the profile," says Jarrett of the corps. "Some of the early designs didn't appreciate that.

"I think the biggest misrepresentation given is that when we go back to renourish a beach, it's a surprise," he says.

But the balance of money spent on construction still dwarfs the amount devoted to monitoring and surveying. For example, of the $7.5 million projected yearly cost of keeping Dare County beaches in place, the corps has earmarked less than 1 percent for monitoring surveys.

"The corps says they've got 30 years experience in beach nourishment," says Stephen Leatherman, director of the Laboratory for Coastal Research at the University of Maryland. "I say they've got one year of experience 30 times."

Michael Halminski

Overwash on Highway 12 at Rodanthe.

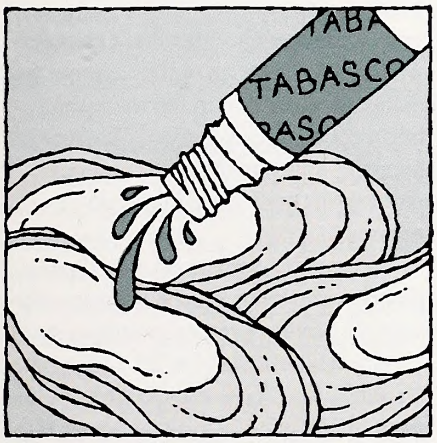
But Jarrett says the corps is constantly fine-tuning beach nourishment design projects and is making an effort to improve follow-up monitoring. Along with the Federal Emergency Management Agency, the corps requested the National Academy of Sciences study, which will look at benefits provided by beach nourishment and its effectiveness as an erosion-control method.

"Unfortunately, we don't do a good job of really documenting what (nourishment projects) do in terms of damage reduction once they are built," says Jarrett.

Many involved in beach nourishment say the benefits provided by beach nourishment to amenities such as tourism and recreation aren't given their due in the cost-benefit analysis. The academy study, which will also evaluate this issue, is due out the middle of this year.

Hold Off On The Hot Sauce

Recent news reports have touted Louisiana hot sauce as a killer of a deadly bacteria that can contaminate raw oysters. But before you start pouring Louisiana's fiery concoctions over your raw oysters, beware, says Joyce Taylor, N.C. Sea Grant's seafood education agent.



Laboratory tests at Louisiana State University Medical Center did show that six brands of hot sauce killed cultured *Vibrio vulnificus*, a deadly bacteria. The doctors who performed the research clearly say their test results are preliminary and apply only to cultured bacteria. The results don't apply to oysters or to people.

Vibrio vulnificus is one of several *Vibrio* species that occur naturally in warm, brackish waters along the Atlantic, Pacific and Gulf coasts. Consumption of *Vibrio vulnificus* can cause illness or even death in certain susceptible people, particularly those with chronic liver disease or an impaired immune system.

Although tests proved positive, the doctors aren't sure how hot sauce affects naturally occurring *Vibrio* occasionally found in oysters harvested from estuarine shellfish beds.

However, some media reports have already made the leap from the test tube to the table, and that is a jump that could create a health hazard, Taylor says.

"Eating raw oysters is risky business, and this research in no way diminishes that risk," she says.

Until more research on hot sauces is completed, Taylor says the only safe oyster is a thoroughly cooked one.

Two Tar Heel Students Named Knauss Fellows

Two graduate students sponsored by N.C. Sea Grant were recently named Dean John A. Knauss Policy Fellows by the National Sea Grant College Program.

Both students, Steve Whitesell and Jessica Cogan, are graduate students at the University of North Carolina at Chapel Hill.

Whitesell was awarded a law degree in December 1993 after receiving a master's degree in regional planning in May. He has a strong interest in coastal management and environmental law policy.

Last summer, Whitesell worked as a legal intern for Walter Clark, N.C. Sea Grant's coastal law specialist, assisting with the formation of an ocean policy framework for the state's coastal ocean management initiative.

Cogan is currently working toward her master's degree in regional planning. She has concentrated her studies in land use and environmental planning with an emphasis on coastal management.

Last summer, Cogan worked as an environmental analyst for Connecticut's Office of Long Island Sound Programs. And she has given presentations about coastal issues at Coastal Zone '93 and the International Coastal Society.

The Knauss program matches highly qualified graduate students with hosts in Congress, the executive branch or appropriate associations/institutions for a one-year paid fellowship in Washington, D.C. Whitesell and Cogan have been selected to work in the executive branch.

Governor Establishes Coastal Futures Committee

Gov. James B. Hunt has named a 15-member panel, the Coastal Futures Committee, to study coastal issues and chart the future of coastal management for North Carolina.

Among those named to the committee is N.C. Sea Grant researcher JoAnn Burkholder, a botanist at N.C. State University. Burkholder is a nationally renowned expert on the effects of water quality on estuarine habitat. She is also credited with discovering a toxic dinoflagellate that attacks and kills fish.

Joining Burkholder on the committee are Richardson Preyer of Guilford County, Justus Ammons of Wake County, Parker Chesson of Wake County, W.B. Fowler of Carteret County, John Greene of Wake County, Stephen Hicks of Jones County, James Holshouser of Moore County, Anne-Marie Kelly of Chowan County, Alex MacFadyen of Wake County, Smith Richardson of New Hanover County, Alice Wells Sadler of Beaufort County, Eugene Tomlinson of Brunswick County, John Wilson of Dare County, David Womack of Pitt County and Milton Heath of Orange County.

Hunt has also proclaimed 1994 the "Year of the Coast" in North Carolina in honor of the 20th anniversary of the Coastal Area Management Act. North Carolina's CAMA governs land-use planning in a 20-county coastal area and has served as model legislation for other states.

Coral May Help in Fight Against Cancer

Sea Grant scientists at the University of Hawaii have taken the first steps toward developing a drug that may prevent cancer.

Since the mid-1980s, chemist Marcus Tius has been investigating a soft coral, *Sarcophyton glaucum*, that inhibits tumor growth. Japanese researchers isolated a compound, sarcophytol A, from the coral that limits cancerous activity.

But harvesting large quantities of the coral for drug development proved problematic. It raised environmental questions, and culturing the slow-growing coral was not cost-effective. Also, the cultured organism may not have the same secondary metabolites as the wild organism, meaning the substances responsible for the anti-tumor activity may not appear.

With the possibility of wild harvest

Continued

eliminated, Tius decided to chemically synthesize sarcophytol A in the laboratory. To synthesize a substance, chemists design and build molecules like architects design buildings. Usually the synthesized compound is slightly different from the original, and chemists call these analogs.

Tius developed four analogs of sarcophytol A, with all retaining an alcohol group that he felt held the key to the substance's anti-tumor activity. After testing, two of the analogs proved successful and were actually more active anti-tumor promoters than the natural sarcophytol A.

Despite these successes, drug development is still a wave of the future. Tius says an even more potent analog is needed before drug development can be contemplated. But he believes that a drug can be developed.

"Such a drug would shield a person from developing cancer," Tius says. "People who are in a high-risk group to develop cancer, such as those who have intestinal polyps, are in remission or have a family history of the disease, would be likely candidates for this treatment."

N.C. Stormwater Management Conference

Stormwater is a universal byproduct of paving and building. Water that runs off streets and parking lots has to be disposed of properly, and it's a planning issue that most local governments grapple with. The latest information in managing stormwater will be presented at the N.C. Stormwater Management Conference, Feb. 17-18, at the Radisson Hotel in Asheville.

Among the presentations will be a talk on stormwater education given by Barbara Doll, N.C. Sea Grant's coastal water quality specialist.

The conference is sponsored by the Land-of-Sky Regional Council and N.C. Division of Environmental Management to help local government officials develop comprehensive stormwater management programs. It will highlight existing and future stormwater regulations and focus on compliance by local governments.

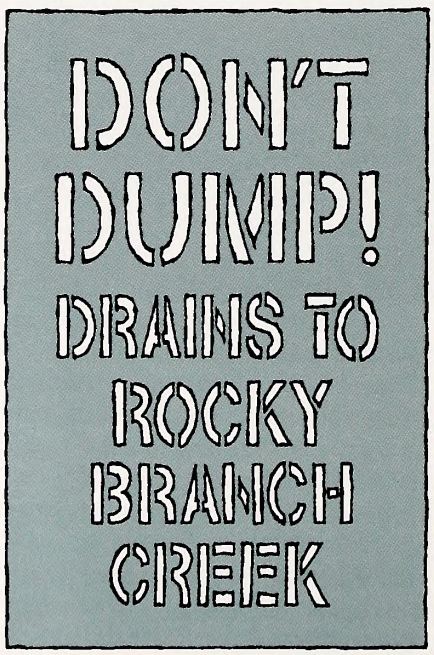
The conference will also be useful to state and federal officials, engineers and project design professionals, homebuilders and economic developers, landowners, water resource professionals, natural resource managers, environmentalists and concerned citizens.

The conference fee is $60 after Feb. 4, and it includes a stormwater management guidebook, other handouts, two lunches and all breaks. For a registration form, write LOSRC, 25 Heritage Drive, Asheville, NC 28806. Or call 704/254-8131 for information.

Painting Storm Drains to Clean Up Rocky Branch Creek

Sometimes spray painting is more than graffiti. It can be a public service.

Environmental clubs at N.C. State University joined a November storm drain stenciling project to heighten awareness of Rocky Branch Creek and reduce the pollution that drains into it. N.C. Sea Grant sponsored the project to stencil about 80 campus drains and catch basins with the phrase, "Don't Dump! Drains To Rocky Branch Creek."



The next phase of the project, directed by coastal water quality specialist Barbara Doll, is to expand stenciling to drains in Raleigh and the coast.

A priority of this effort is to heighten awareness of rivers, creeks and estuaries and to alert the public that discharges into storm drains can pollute these valuable resources, Doll says. After a rain, water and pollutants from streets and sidewalks collect in these drains and travel to nearby waters through a series of pipes that make up the stormwater system. These drains are also commonly misused as dumping sites for paint, grass clippings, street litter, motor oil and other wastes.

"Many people either don't consider where these drains go or they assume the drains are connected to the wastewater treatment plant," Doll says. "This type of nonpoint source pollution is a serious problem for most urban lakes and streams."

Currently, storm drain stenciling programs are reducing urban water pollution in 31 states. Leading programs are in Virginia and Maryland in the Chesapeake Bay area, New York and Connecticut in areas draining to Long Island Sound and Florida. In North Carolina, Doll and state agencies are working to expand storm drain painting projects.

The recent NCSU stenciling project targeted drains on university property in the watershed of Rocky Branch Creek, which drains into the Neuse River via Walnut Creek. Over the years, the creek has been plagued by problems associated with development and urban activities. It was once declared the state's most polluted urban stream by the N.C. Division of Environmental Management. Today, it continues to suffer from algal blooms, slimy green algae on rocks, severe sloughing and erosion of the streambanks, damaged culverts and storm drain systems, poor water clarity and surface patches of oil and grease.

Doll is working with NCSU to repair the environmental damage to the creek. In addition to the stenciling project, she is involved in a larger campus project to stabilize the Rocky Branch streambanks and improve water quality.

For more information about storm drain stenciling, contact Doll at 919/515-5287 or write her at N.C. Sea Grant, Box 8605, Raleigh, NC 27695-8605.

Seafood Plant Poster

Hygiene is a top priority in any food industry, including seafood processing. But in the day-to-day rigor of doing their jobs, workers sometimes forget basic cleanliness rules.

That's why David Green, N.C. Sea Grant's seafood technology specialist, developed a poster listing 10 important hygiene tips for seafood plant personnel. Written in English and Spanish, the 12-by-24 inch poster reminds workers of the importance of plant and personal cleanliness.

The eye-catching poster, which is accented by line drawings, will lure employees to read the helpful tips. Green recommends hanging it in a processing plant break room or entrance hall. And the Spanish translation can be helpful for processors who employ Mexican migrant workers.

The poster was jointly produced by the Sea Grant College Programs in North Carolina, Puerto Rico, Alaska and Texas. For a free copy, write N.C. Sea Grant. Ask for UNC-SG-93-03.

In the Belly of a Whale

Last December, a 28-foot sperm whale washed ashore at Wrightsville Beach. The emaciated female marine mammal soon died in the surf.

When veterinarians and biologists performed the necropsy, they found the whale's belly full of marine debris — nylon rope, a plastic gallon bottle, a plastic bag and a fishing float. Veterinarians believe the whale starved to death because it couldn't get enough "real" food into its stomach.

Now, N.C. Sea Grant's marine education specialist Lundie Spence, underwater cinematographer Bill Lovin, Environmental Media and the N.C. Big Sweep have joined forces to make the whale's death an unforgettable lesson about the dangers of marine debris. A 17-minute video, "The Death of a Whale," examines why the marine mammal died and the implications of its death for the health of our marine environment.

"The video poignantly points out how marine debris threatens and kills our wildlife," says Susan Bartholomew, executive director of N.C. Big Sweep, the nation's largest statewide waterway litter cleanup. "Students or adults who watch 'The Death of a Whale' will be affected by what they see and will better understand why we ask people not to litter."

"The Death of a Whale" is suitable for use in junior and senior high school biology, marine science or environmental study classes; 4-H clubs; Scout groups; and college classes.

For North Carolina educators, the cost of the video will be $9.95 plus shipping. For others, the cost is $24.95 plus shipping. For ordering information and shipping costs, contact Environmental Media at 1-800-ENV-EDUC (1-800-368-3382).

A Catch of a Video

Shrimping is the most profitable commercial fishing venture in the Southeast. But when the nets are hauled back, along with the shrimp comes an unwanted mixture of sea creatures called bycatch. Despite fishermen's efforts, most of the bycatch dies before it can be culled and tossed back in the ocean.

In recent years, bycatch has created controversy, especially between recreational and commercial fishermen. Recreational anglers claim that many of these "unwanteds" are juvenile fish that are filling the bellies of gulls instead of swimming in the ocean as tomorrow's catch.

To solve the problem, N.C. Sea Grant Marine Advisory Service agents have been working with fishermen and netmakers to design nets and devices that will reduce bycatch. And Sea Grant has documented this effort with a new video, "Reducing Bycatch: The Fishing Issue of the '90s."

For a copy of this 14-minute video, write Sea Grant and ask for UNC-SG-93-08. The cost is $12.

Skimming the Video Shelves

In another fishing video, N. C. Sea Grant agents describe their work with the skimmer trawl, a net configuration used by Louisiana watermen to net shrimp in shallow bayous.

Sea Grant agent Bob Hines tested the skimmer trawl, a cross between a butterfly net and a Vietnamese "chopstick" rig, to see how Bayou technology worked in Tar Heel estuaries.

The findings were favorable.

The skimmer caught significantly more white shrimp than the traditional otter trawl used by North Carolina shrimpers. And it reduced bycatch. Now fishermen are adapting the skimmer for catching pink and brown shrimp too.

To follow the skimmer trawl project from its conception to its findings, send for the 11-minute video, "Shrimping with the Skimmer." It's available from Sea Grant for $12. Ask for UNC-SG-93-09.

All Aboard for Recycled Plastic

A Virginia Sea Grant specialist recently tested the use of recycled plastic for bin boards in fishing vessels. Bin boards and bin shelving are used to contain and support ice-stowed fish and shellfish in the holds of fishing vessels.

Traditionally, yellow pine or spruce lumber was used to build the bins. But the wood sometimes caused product contamination, and an alternative was needed.

Virginia Sea Grant specialist Robert Fisher decided to give recycled lumber a try. After comparing the recycled lumber to yellow pine, Fisher found the plastic was more efficiently cleaned and sanitized and was preferred by fishermen. The recycled lumber was also cost-efficient because it required little maintenance or replacement.

To learn more about this study, send for Virginia Sea Grant's new publication, *The Use of Recycled Plastic for Bin Boards in Fishing Vessels*. It's available free from Virginia Sea Grant, Marine Advisory Program, Virginia Institute of Marine Science, Gloucester Point, VA 23062.

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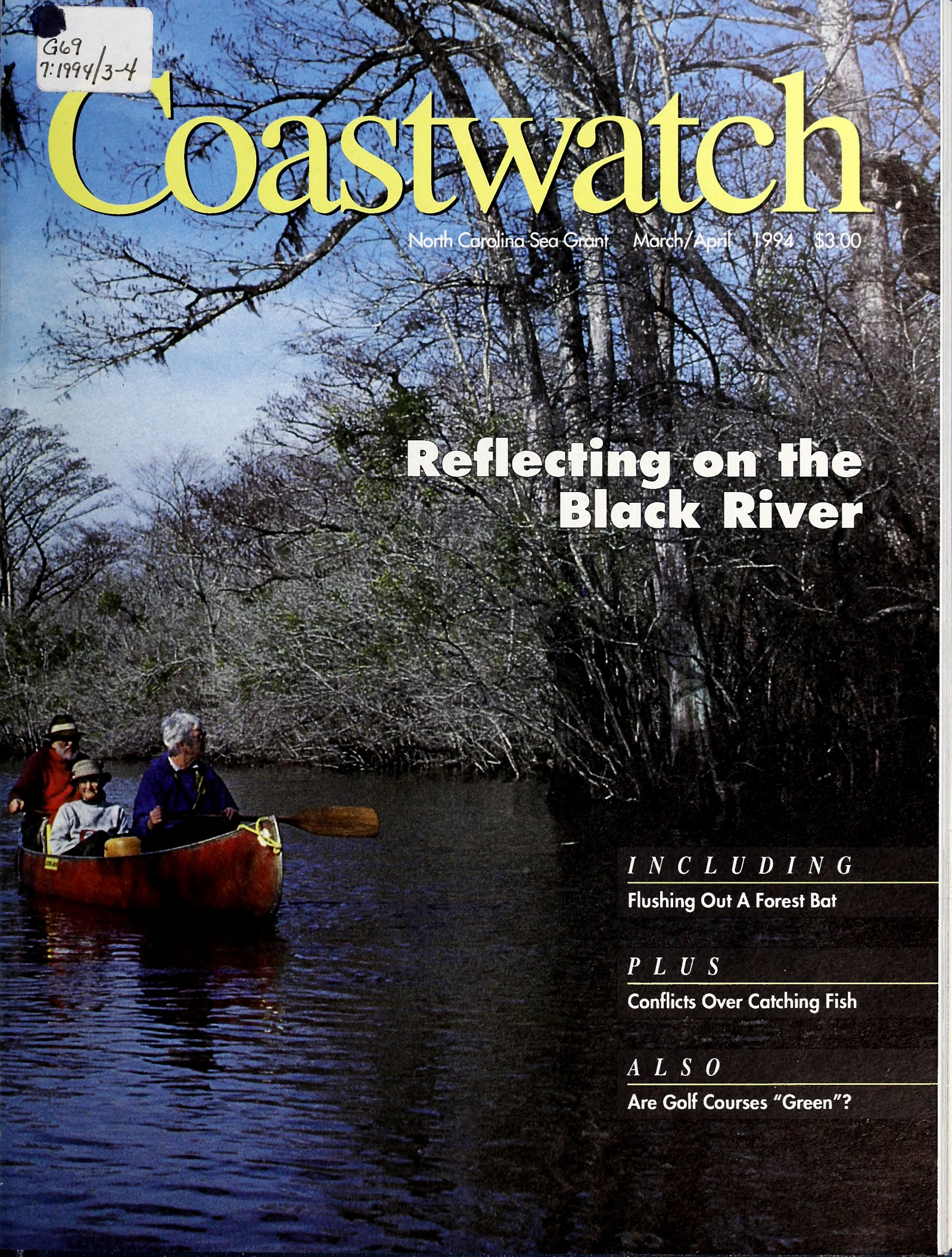

Reflecting on the Black River

INCLUDING

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PLUS

Conflicts Over Catching Fish

ALSO

Are Golf Courses "Green"?

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, N.C. Sea Grant supports several research projects, a 12-member extension program and three communicators. B.J. Copeland is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

Coastwatch (ISSN 1068-784X) is published bimonthly, six times a year, for $12 by the North Carolina Sea Grant College Program, N.C. State University, Raleigh, NC 27695-8605. Telephone: 919/515-2454. Fax: 919/515-7095. E-mail k_hart@ncsu.edu. Second-Class Postage paid at Raleigh, N.C.

POSTMASTER: Send address changes to *Coastwatch,* N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Front cover photo by Scott D. Taylor. Betty Martin, Catherine Sloan and David Martin skim the surface of the Black River in January.

Inside front cover photo of Black River by Scott D. Taylor.

Printed on recycled paper by Highland Press Inc. in Fayetteville, N.C.

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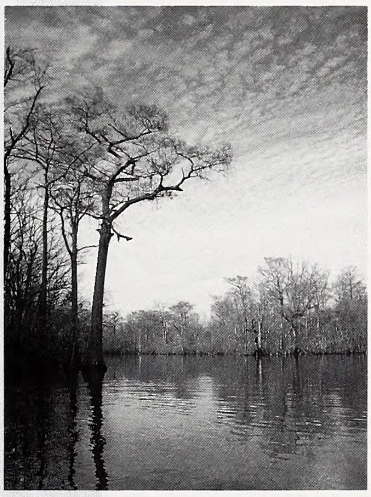

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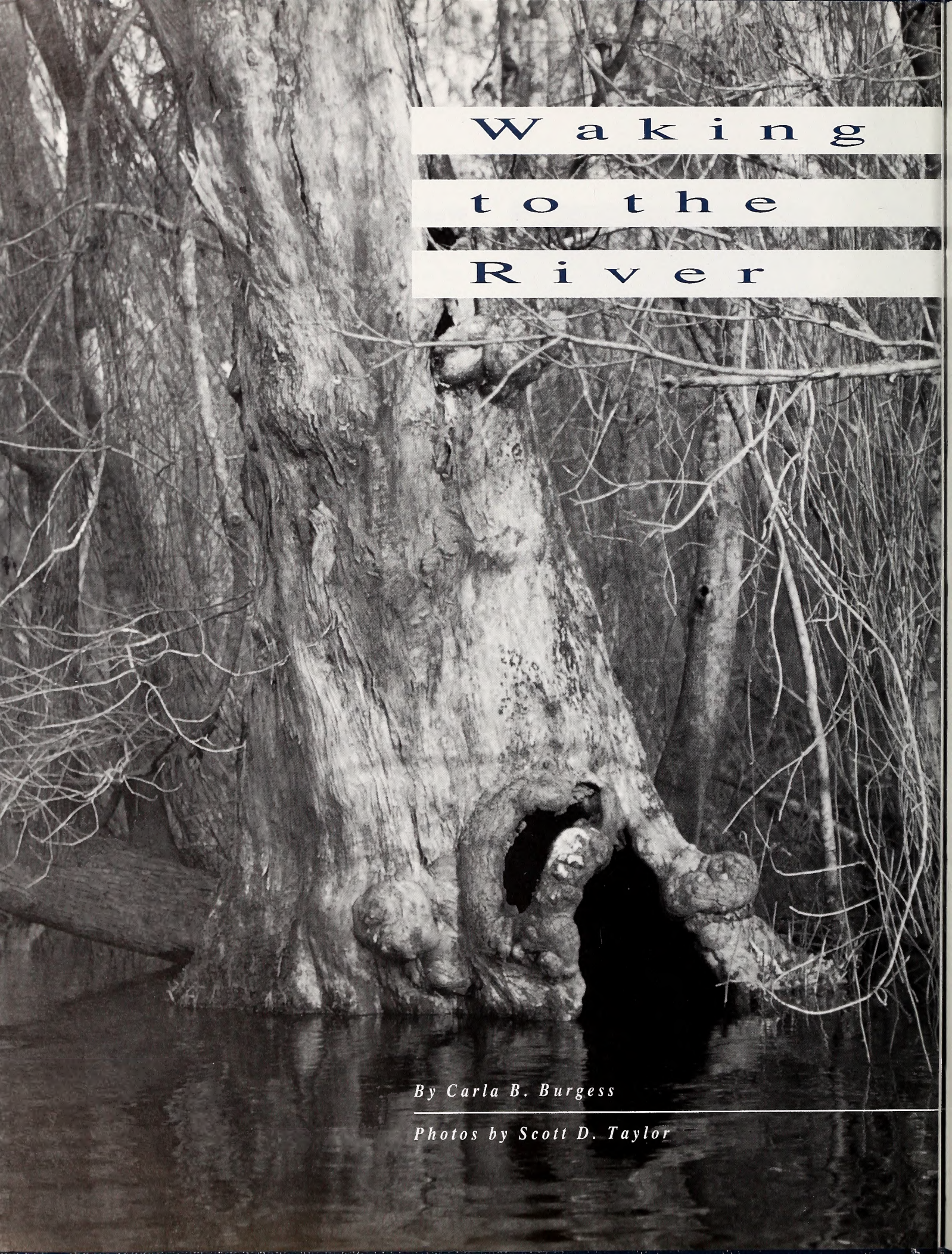


Waking to the River

By Carla B. Burgess

Photos by Scott D. Taylor

My granddaddy A.A. died several years before I was born near the floodplains of the Black River. Yet he left me a gift that could only have been more precious had I taken it from his hands. A month before his death, he bought 210 acres of Sampson County farmland between the old North Carolina railroad towns of Kerr Station and Ivanhoe. It was there — in the shadow of the Black's cypress, gum, live oak and loblolly pine — that I spent my childhood in awe of his legacy.

My family lived a half-mile from the banks of this blackwater river in a two-story antebellum house cluttered with antiques. Window screens were our air-conditioning; the songs of owls and whippoorwills in the swamp, our vespers.

The river was ever present in our lives. At our berth on the Black — Jackie Landing — local fishermen would net the bounty from the spring runs of herring, frying the bony fish to a crisp in cast-iron cookers and scrambling the roe with eggs. These evenings were dark and smoky and delicious. In the swamp, I was an honorary Boy Scout, playing Capture the Flag, building rope bridges and going on fruitless "snipe hunts" with my brothers.

My stewardship efforts along the Black began early with a concern for bear, deer, bobcat and other animals. At 9, I nailed to a tree a piece of cardboard on which I wrote in magic marker: "Wildlife Preserve: No Hunting. No Loud Talking." The soggy sign was my declaration to the world that this was a hallowed place. Now, almost 20 years later, the world is awakening to this slow-winding tributary of the Cape Fear River.

I expanded my own appreciation of the Black River on a canoe trip in January, gorging on a sensory feast and rekindling my love for a river that has flowed through my life.

Formed by the confluence of Great Coharie and Six Runs creeks in the belly of Sampson County, this 66-mile stream siphons the South River, then winds through Bladen and Pender counties before spilling into the Cape Fear about 16 miles above Wilmington.

Cypress knees

Though the watershed drains such larger towns as Clinton and Dunn, the Black River skirts mostly sleepy communities such as Harrells, Atkinson and Currie.

Its centuries-old cypresses have landed the Black in the pages of *The New York Times* and *Audubon* magazine and rooted the river in the public consciousness. In the early 1980s, the state's Natural Heritage Program alerted an Arkansas researcher to an area of old-growth bald cypress along a 9-mile section near the river's midpoint. The scientist, who studies the history of world climate change by coring old trees, expected to find specimens a couple of hundred years old. What he found were trees that most likely shared the earth with Jesus Christ.

"It's my firm belief that there are many 2,000-year-old trees at Black River," says David Stahle, a dendrochronologist at the University of Arkansas at Fayetteville. "The oldest one we've found is 1,700 years old. But many of the super-old trees get heartrot, and we've only cored a small fraction of the ancient trees still present on the Black. It's reasonable to conclude that some of the old Black River cypress have been there for over two millenia.

"These are the oldest trees that we know of in eastern North America and some of the oldest in the world," says Stahle, who is using his tree-ring data to reach centuries into the past to reconstruct drought patterns and possibly predict climate variation in the future. Stahle has also cored long-dead trees preserved in the water to further extend the chronology.

The ancient cypresses may be the river's biggest celebrities, but pristine water quality, unusual plants and animals and undisturbed scenic beauty also distinguish this coastal plain tributary.

Two rare fish, the Cape Fear chub

Continued

Black River communities seem to revere their river more than other towns do their streams. Perhaps this awe and respect will protect its future as much as any regulation ever could.

Richard Cecelski, marine educator and canoe guide

and the broadtail madtom, swim the Black. The Atlantic pigtoe and the yellow lampmussel, two rare freshwater mussels listed among the state's threatened species, also thrive in the river. The stream's mussel population is diverse.

"One of the most striking things about the Black River system is the abundance of freshwater mussels, and that is a clear indication of good water quality," says the state's "mussel man," John Alderman of the N.C. Wildlife Resources Commission.

The mussels are food for fish and, at various life stages, for the river's ducks, muskrats, raccoons and otters. These tiny two-shelled animals once completely "tiled" the bottoms of rivers. They can provide substrate for small invertebrates such as caddisflies, which dwell on the bottom as larvae and are intolerant of polluted water.

The Nature Conservancy has acquired almost half of the nearly 1,900-acre old-growth cypress swampland straddling Pender and Bladen counties. It is seeking conservation easements from private landowners to preserve the remaining riverfront forest.

Meanwhile, others are striving to safeguard the water itself. The Black and a portion of its major tributary, the South River, as well as a section of Six Runs Creek have been nominated as "outstanding resource waters." The designation has been recommended by the state's Division of Environmental Management, Wildlife Resources Commission and Division of Parks and Recreation and the U.S. Fish and Wildlife Service. If approved, the state would implement a special management plan that would prohibit new or expanded wastewater discharges to the designated stream segments and limit development and associated stormwater runoff near their banks.

To qualify for this supplemental protection, the area must have excellent water quality based on water chemistry and biological activity. The upper portion of the Black, which has exceptionally clean water, was reviewed and reclassified as "high quality waters" in 1990. The state believed

Richard Cecelski, his dog Amber and Mary Ann Brittain.

Catherine Sloan pilots Betty and David Martin through bald cypress swamp.

other areas of the watershed were equally clean and met the values associated with outstanding resource waters. This label may apply when excellent water quality is accompanied by one of the following five resource values: an outstanding fishery resource, a high level of water-based recreation such as boating or fishing, a special designation such as a National Wildlife Refuge, inclusion within a state or national park or forest, or special ecological or scientific significance. The 75 river miles under consideration clearly meet at least two of these outstanding resource values — water-based recreation and ecological and scientific significance. The jury is still out on the fishery assessment because of adverse sampling conditions.

The entire Black River and a portion of the South are on the National Park Service list of proposed "wild, scenic and recreational rivers." State parks wanted to affix the label "state natural and scenic river" in the late 1970s, but private landowners who feared condemnation of their property squelched the plan. Public support for the outstanding resource classification has fared much better.

At a public hearing in September and in a slew of letters mailed to the state since, many landowners and conservationists praised the proposal. But at that same hearing, a minority — including some downriver farmers — were sour on the plan, saying they and generations of their families had kept the Black River pristine and would continue to care for it without being forced by the government.

But these downstream landowners — good stewards or bad — can't control what happens above them.

"Can they speak for the people who live in Clinton?" asks Dave Lenat, a DEM environmental biologist. "If a new industry wants to go in there and says, 'I'm going to employ 1,000 people. What kind of compensation will you give me here? Can I discharge my stuff?'"

Urban runoff and wastewater discharges in the upper basin disqualified

Continued

Years from now, when development has taken so very much from us, the wildness of our rivers will be of greater value than we might ever imagine.

Douglas Little, Six Runs Creek, Black River Boats

Having lived in a desert for 10 years, we know why the ancient cultures worshipped rain gods — they knew what was most important.

Dorothy Harte, Palm Springs, CA (father's family settled on the Black River in mid-1700s)

the Black's headwaters and the upper South from ORW consideration. But the river water recovers in the slow, purifying filter of the downstream swamps. David Martin, president of the South River Association and an advocate for river protection, says the Black's classification must be nailed down before water quality is compromised.

"It's worth a lot of money to find a stream to put pollutants in," says the retired N.C. State University physics professor. "You have to have a good chunk of river that has low enough pollution in it to where the wastewater will not take it up over the standards.

"None of the outstanding resource waters that have been designated up until now has threatened any kind of major industrial use," Martin says. "They've all been way up in the mountains or ... down in the marshes where industry doesn't want to locate anyhow. The South and Black rivers, those are viable water sources; they're clean and they're ready for pollution."

People say that a trip down the Black is to travel back in time. You won't see the log rafts and steamers that floated passengers, lumber and turpentine down this once-bustling commercial highway through the turn of the century. But from your vessel, you'll see forest primeval and be propelled by slow-moving, shallow water that seems unsullied by the developer's hand.

"A lot of canoeists go out on the river and see what appears to be an undisturbed area," says Lenat. "But often just behind the trees is a vast agricultural field."

For almost 20 years, Douglas Little has lived about a mile above the headwaters of the Black on its eastern source tributary, Six Runs Creek. As a Charlotte high school student in the early 1960s, he spent summer vacations in Sampson County helping his uncle hang Funk's G Hybrid Seed Corn signs on tobacco barns for $1 apiece. He was charmed by the region's creeks and crannies and built a home here in 1976.

Little and his family earn a living crafting small electric boats out of juniper. He lives with his wife and two sons, 11 and 15, 150 yards east of the riverbank, a rare opportunity on this typically flat floodplain.

"My boys are quite at home in the water, no matter how dark, how deep or how snaggy," he says.

Little has paddled a canoe from his house to Carolina Beach and in and around nearly every cove and slough between. At least one day a week on the Black, he tests his wooden craft, which are quick and quiet shallow-draft vessels well-suited to the terrain. Black River Boats are made of only dead Atlantic white cedar, salvaged, with permission, from a nearby hog farm.

"There's more dead wood than I can harvest," he says. "It's a mixed blessing."

Little never misses an opportunity to talk up the river, whether he's describing a winsome otter munching on a catfish or guiding a visitor through a beguiling backwater slough. Like other supporters of the river's reclassification, he knows it will take more than laws to protect the Black.

It will take the people who meet it and the people who love it.

A good 30 river miles south, I am preparing to introduce the Black to a few new friends. We are a dozen miles downriver from Jackie Landing and a couple of miles from Ivanhoe, but it is still familiar territory. My father helps us unload two kayaks and two canoes beneath the state road that crosses the river at Beatty's Bridge. In my mind, I recall the voices of children and teenagers swimming here on a hundred summer Sundays. I hear my oldest brother Fil assuring me that our splashing will keep the cottonmouths at a distance. And I remember Richard, my other brother, diving from the bridge into the water, sacrificing three of his permanent front teeth to the concrete guard rail.

This favored swimming hole made the big screen in 1991, when a sweaty, sultry Laura Dern slinked across the bridge on her way to the nearby Corbett mansion in the movie "Rambling Rose."

It is warm enough for mosquitoes and moccasins, but today is merely Jan. 6. The snakes are asleep beneath stumps and logs. If they knew of the 70-degree forecast for tomorrow, they might sneak out for a sunbath.

Richard Cecelski has led 30 trips on this stretch of the Black, mostly during his days as an educator with the N.C. Aquarium at Ft. Fisher. Along with his brother and dog Amber, Cecelski enthusiastically agreed to help us chart the narrows of the old-growth cypress swamp. My other companions, science educators from Raleigh and a Beaufort photographer, are new to the Black. As we paddle west around the bend that is the turnaround point for most water-skiers, I too slip into virgin territory.

At normal water, the river is as broad as 500 feet in some spots. But we are headed toward the "narrows," where the river's flow leaves the channel and seems to disappear in the cypress swamp. By the next morning, when we leave our camp at Squalling Bluff about five miles downstream, we'll know why early settlers called this the Stumpy River. In spots, the channel is only as wide as the length of our canoes, and we dart among fallen trees and duck low-hanging limbs.

The bone-gray woods are striking in winter. Resurrection fern — in a cycle of shrinking and hydrating — clings green to bare tree boughs; clumps of pearl-berried mistletoe hang on branches high and low. Occasional pines and the mossy crowns of cypress knees — the trees' aerial roots — also infuse color.

When the wind is still, the river's reflective quality can induce vertigo in the steadiest of paddlers. It's as if you could fall overboard into the sky. The molasses-colored water derives its hue from dissolved organic matter and tannic acid, giving the Black its name.

On our first day, the mirrored surface is seldom disturbed. We are surprised only once, as we see and feel a front push through the treetops and dissipate like a ghost upstream. A red-shouldered hawk cuts a soft circle overhead.

As we near the spot on which we'll pitch our tents for the night, two Clinton fishermen anchored near the bluff show off their prizes — a shimmering, jade-colored crappie, a popular winter fish, and a redfin trout or raccoon perch, so named for its brown and white stripes. The Black is also well-known for its abundant sunfish.

The east bank of the river here is known as Cone's Folly after the Greensboro family that owns the land. It is hard to believe that anyone could consider this purchase an unwise venture. But it was frequently flooded territory, and logging was certainly hindered. As the channel shrinks east of Three Sisters Swamp about a mile downstream, the cypress were even more elusive. The geography of the river made it difficult to navigate and to float logs downstream.

"Those areas are more remote and less vulnerable to the ax," says Cecelski. "That, probably more than anything else, saved those trees from being cut."

> *This is the best thing I've ever done in my life as a scientist. That we here at Arkansas could have contributed somehow to the preservation of this important place makes me very happy.*
>
> ***David Stahle, dendrochronologist, University of Arkansas at Fayetteville***

Cecelski also notes that there was more money to be made from resources of the prolific longleaf pines on the upper Black. Unlike lumber, the valuable tar, pitch and turpentine products could be transported through the narrows in smaller vessels.

There was also a notion — perceived if not real — that many of these cypresses were defective timber. There are "shakes" and twists and burls in the wood. And many of the ancient trees are hollow. They also are not very large, says Stahle, noting that the cypresses' longevity was achieved under adverse conditions.

"This is a starved-out blackwater system with low nutrients," he says.

The trees became as big as they are

Continued

only by persevering. Back when these forests were virgin, the trees were much smaller and less appealing than the bald cypress bordering rivers that drained the more fertile soils of the Piedmont, such as the Cape Fear, says Cecelski.

Logger Nelson Squires, who runs a hardwood mill near Kelly, says plenty of solid cypresses were overlooked. The grain is "almost honeycomb-like" and makes beautiful paneling, he says. But Squires wouldn't lay an ax on them.

"They've been through a lot; they're tough," says Squires, who has given The Nature Conservancy a conservation easement along several acres of old-growth below Three Sisters Swamp. "It means a lot to go in there and know that you can ride up and down and have it look like it did when the first settlers came over. I hope it's that way 500 years from now."

Squires has granted the first Black River easement of this kind to The Nature Conservancy. He still maintains ownership of the land and can hunt, fish and even build a pier if he wants to. But the trees stay put. Squires favors the reclassification of the river and says he supports any effort to keep it clean.

"I would fight tooth and toenail to keep industry from putting pollutants in the water," he says.

With the permission of the Cone's Folly caretaker, we pitch our tents at the edge of a large oval cove. It envelops us under a moonless sky that night, as Scott Taylor, his camera and I investigate in our canoe. In daylight, we had discovered a photogenic family of "hairy swamp gnomes," Taylor's moniker for the cypress knees that protrude from the water and encircle the trunks like sentry guards. We find them again with the wide beam of a flashlight, a few submerged ones glowing like coals in the tannin-stained water. Some speculate that these roots help the inundated cypresses take in oxygen. And the broad buttressed trunks — sometimes spanning 15 feet across — help the shallow-rooted giants keep their foothold in the wind.

My mom would say these trees are "in their element," and she's right. I recall Stahle's explanation that in drier soils, the sluggish cypresses often can't compete with other trees; they are overtopped by faster-growing hardwoods. But able to tolerate saturation, they find their niche in the swamp. And because the sensitive responses to rainfall and drought are echoed in its growth rings, bald cypress is a premier species for studying climate history worldwide, Stahle says.

This was once thought implausible because the trees grow in water. Climatologists once focused mostly on trees in the arid Southwest. But apparently cypress responds to both the quality of the water as well as quantity, says Stahle, noting that rainfall tips the balance of nutrients in the swamp water.

On a night like this in July, we'd be deafened by a chorus of frogs and sucked anemic by mosquitoes. But we hear only our paddles slicing the surface and one loud whip of a sleepless, large-winged bird 50 feet up. I imagine the ghosts of the extinct Carolina parakeet in nearby hollow tree roosts. The green and yellow bird, North America's only native parrot, is thought to have been the only agent of dispersal for cypress upriver. The heavy seed-cones of bald cypress bob downstream on the current. But only the parakeet, which ate the ripe kernels, helped the trees spread upriver and between river basins. The brilliant bird faded from existence by the early 1900s.

The temperature barely dips to freezing that night, but the wakeup air at Squalling Bluff is brisk. A trio of South River canoeists catch up to us as we paddle toward our rendezvous at the N.C. 53 bridge another five miles below. A deer sounds reveille, cracking the underbrush as it canters along the west bank. The wind is up, and we skim ahead to see the flat-topped relics of the old-growth cypress swamp in the morning light. Their straight stems have sloughed off their lower branches with age and pushed upward — sometimes 80 feet or more — into a squashed, flat canopy. Scott remarks that they look like neurons or ganglia scratching the sky.

Along the banks, we admire the stick houses of beavers but catch no glimpse of their occupants. The nocturnal creatures work prodigiously from dusk to dawn, reclaiming wetland habitat.

Farther downstream, a lone green tree frog sits motionless like a bell pepper in the leafless brush. The creature marks the entrance to one of the fingers of Three Sisters Swamp. We slip into the narrow slough and into the past. I imagine the face of King Arthur's venerable Merlin in the old trees' twisted grain and his beard in the garland of Spanish moss. But two old highway signs — "Detour" and "Stop" — hang like anachronisms from a couple of cypress trunks, vaulting me back to the present.

With Cecelski's guidance, we explore elder trees in a large cavity known as Balsa Lake, fed by the river's lower narrows. In this voluminous cove, Stahle and his associate cored the first rugged cypress, 1,200 years old.

The Black is, on this day, a comfort to me. Like Squires, I want its beauty to be known to future generations. And like so many people have said to me these past few months, there is peace of mind in knowing it is here, even when you are somewhere else.

A few miles upstream, just above Ivanhoe, Stacy "Red" Butler and his wife Claire keep the keel of the small steamer *Delta* as their link to yesteryear. Its mooring was just downhill of their cabin at Delta Landing. Claire fishes for supper in the river — channel cats, bullheads and striped bass. Red grows fields of millet, corn and milo for the flock of almost 200 Canada geese and mallards he raises on a nearby pond. The birds are somewhat tame, and Red tries to protect them from local hunters with signs posted in the swamp. He raised an orphan fawn, bottle-feeding her in infancy. Until she died recently of old age, he would "call her up" from the woods to offer cookies and melons.

"I think the deer out here all think

their names are Maybelle," says Claire.

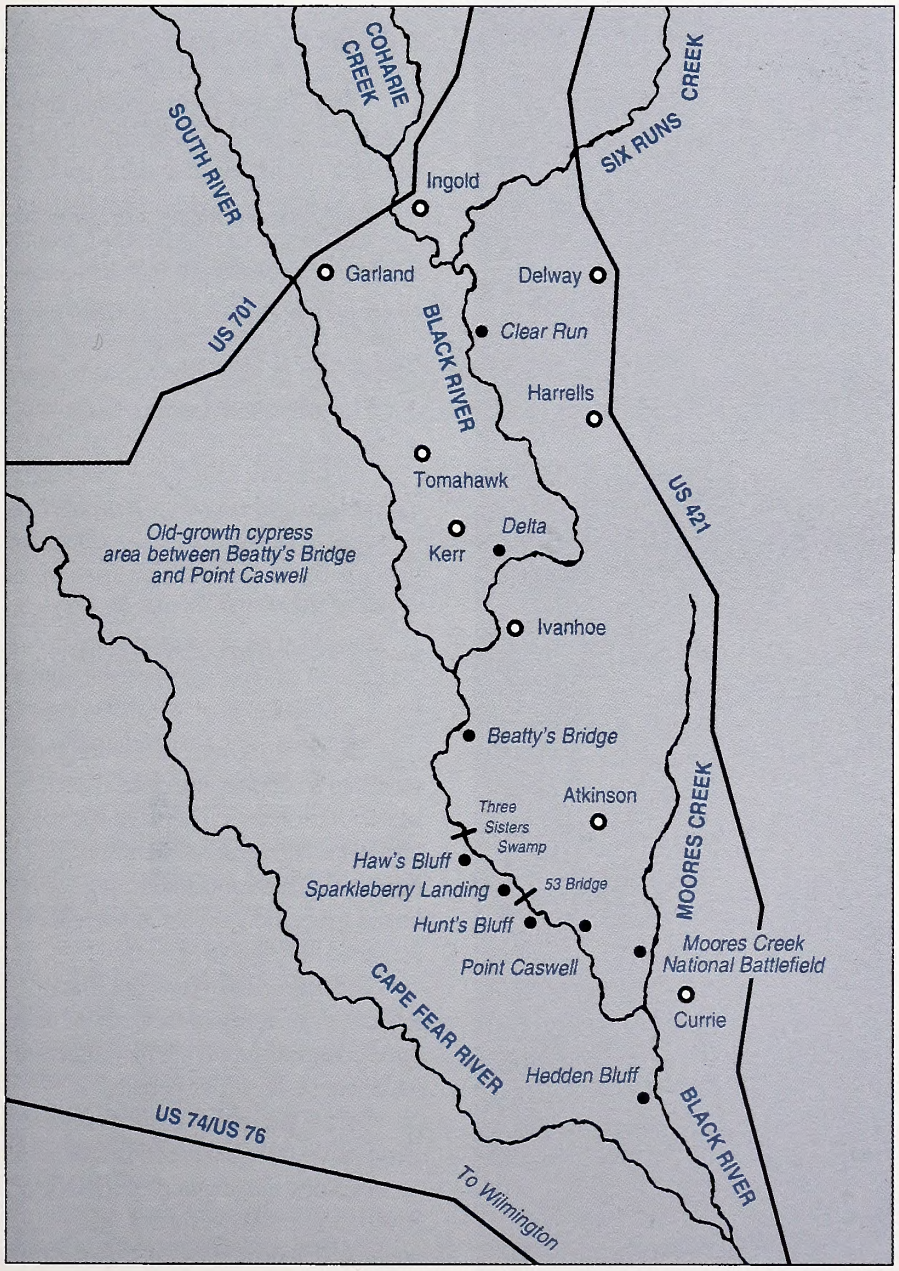
In the evenings, the two watch the aerial antics of leatherwinged bats diving for mosquitoes. They've observed a treeful of transient cormorants and even spied an anhinga. They also eavesdrop on the low conversations of great horned owls.

"They discuss things all night long," says Claire. "They've created new policies, I believe."

Maybe the birds are contemplating their future in this idyllic setting. Claire knows that she and Red are lucky to be one of the few permanent residents of the Black's banks. And they hope the river can withstand the relentless pressures it will surely face.

"It would be such a shame for it to be polluted," she says. "But we're practical. It's only a matter of time."

NOTE: It's been more than four years, and the Black River is still awaiting its coronation as outstanding resource waters. The day before the proposal was to be presented to the Environmental Management Commission for a vote Feb. 10, the officers who conducted the public hearing prepared to wholeheartedly recommend approval. But at the meeting, Steve Tedder, chief of the Division of Environmental Management's Water Quality Section, advised the commissioners to table the issue. Tedder says the data collected in the ORW research has not been proven consistent with new information gathered by the division in a basinwide study of the Cape Fear watershed. The issue may resurface at the commission's regular meeting in April.



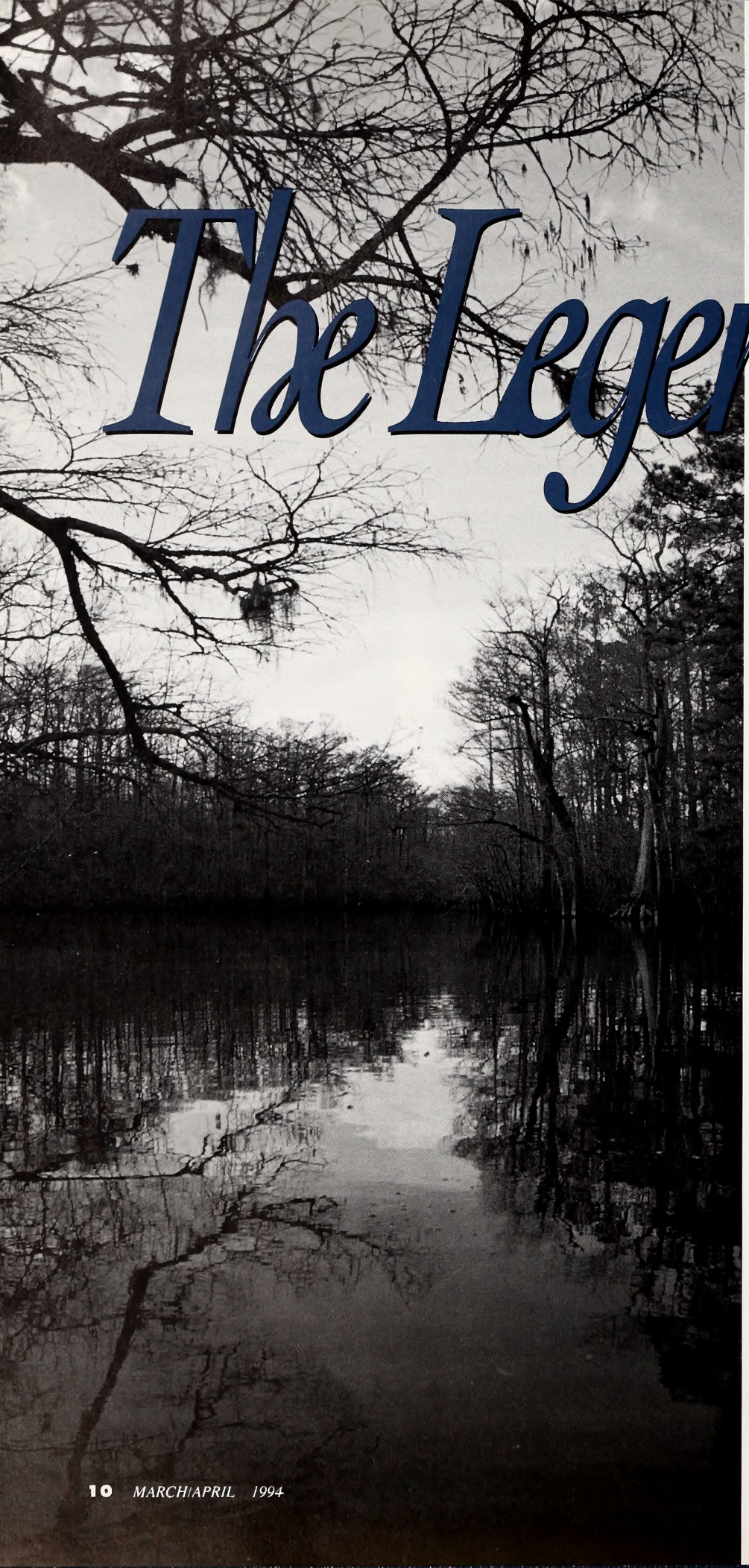
Cypresses
Robert Francis
(1901-1987)

At noon they
talk of evening and
at evening
Of night, but what
they say at night
Is a dark secret.

Somebody long ago
called them the trees
of Death and
they have never
forgotten.
The name
enchants them.

Always an
attitude of
solitude to point
the paradox
of standing
Alone together.

How many years
they have been
teaching birds
In little schools,
by little skills,
How to be
shadows.



The Legend of

By Kathy Hart

Today, the Black River is quiet.

Only the sounds of nature echo across its waters and resound through the cypress, cedar and pine that guard its shores.

But there were noisier days — days when landings along the river were alive with people, steamboats shrilled their whistles and polers shouted from raft to raft as they pushed their loads down the river.

For the historian willing to look into its depths, the river's black beauty mirrors a rich heritage and a legacy to the people of Sampson, Pender and Bladen counties. It has linked generation to generation and neighbor to neighbor.

For nearly 200 years, the Black River was an artery in the body of these three counties, supplying the lifeline of trade that sustained its people.

Before the arrival of the Europeans, Native Americans paddled their canoes along the length of the Black River and hunted the forests that hugged its shores.

Scott D. Taylor

Black Beauty

When the Europeans — mostly Irish, Scots, English and Welsh — began settling southeastern North Carolina, the river became an avenue for commerce. Settlers quickly realized that the forests of pine offered an almost inexhaustible source of tar, pitch, rosin and turpentine.

During spring and summer, colonists drained resin from the abundant pines of the coastal plain in much the same way as New Englanders tap the sweet sap from sugar maples. Using large stills, woodsmen distilled the sticky pine gum into turpentine and its byproduct rosin, which was used to make soap, varnish and shellac among other things.

Bleeding pines of their life-sustaining resin often killed the tree after several years. Then, resourceful woodsmen used the dead wood to produce the sticky black tar that was coated on wagon axles, smeared on livestock wounds, mixed into cough syrup and exported by the barrel to England and its colonies.

Kilns were used to process tar. Woodsmen stacked the kilns with live or dead wood. The wood was ignited and smoldered. Only a slow burning would force the tar ooze from the pine wood. If a fire blazed too fast, the tar would burn and the kiln would explode.

Barrel after barrel of tar was produced in this crude fashion among Black River and other Cape Fear forests. A kiln 30 feet in diameter stacked 14 feet high with wood could yield 160 to 180 32-gallon barrels of tar. Once used, however, a kiln was abandoned. Even today, evidence of these kilns can be found in southeastern forests.

During the Colonial period, naval stores were a cornerstone of the Cape Fear basin economy. Colonial records reveal that North Carolina was the largest producer of these wood byproducts, and slightly more than half of the state's production left from the Cape Fear port of Brunswick.

To convey these and other goods to market, Black River settlers loaded them aboard canoes, periaugers, flats and rafts. John Brickell, writing in 1737, told how settlers built their canoes from the durable giant cypresses that reigned as kings of the coastal swamps.

A tree of sizable width and length was felled and cut. The resulting log was shaped like a boat, and its center hollowed. Sometimes the canoe was expanded by splitting the hollowed log down the middle and adding boards to the bottom. This wider boat, called a periauger, was capable of hauling as many as 50 barrels of tar or pitch.

The same forests that yielded a steady supply of naval stores also provided mountains of timber. Colonists felled pine, oak, walnut, cypress and cedar. Before the Revolutionary War, the forests of the Cape Fear basin yielded 2.5 million to 3 million feet of lumber per year. North Carolina was second only to Massachusetts in lumber production.

Large landowners built mills for sawing the logs into lumber. To move the wood, cut or uncut, from forest to market, woodsmen relied on water for transportation. In most cases, the wood was lashed together to form large rafts and steered down the river by men known as raft runners, who used only poles and oars to guide their cargo. Often, rafts were linked together to form long trains that snaked down the river like an unclasped string of pearls.

On the upper Black River and its feeder streams, the Coharie and Six Runs, the runners relied on currents to push the rafts downstream. But on the lower portions of the river, tides influenced travel. Raft runners utilized the pull of outgoing tides to move downstream, but tied their trains of rafts to the riverbanks to avoid the upriver current of inflowing tides.

Raft runners were hardy. They worked mostly in the cold of winter and early spring when the Black River was swollen with rainwater that made it deeper, wider and swifter. Runners slept without shelter along the damp riverbanks and braved the treachery of river currents, eddies and snags.

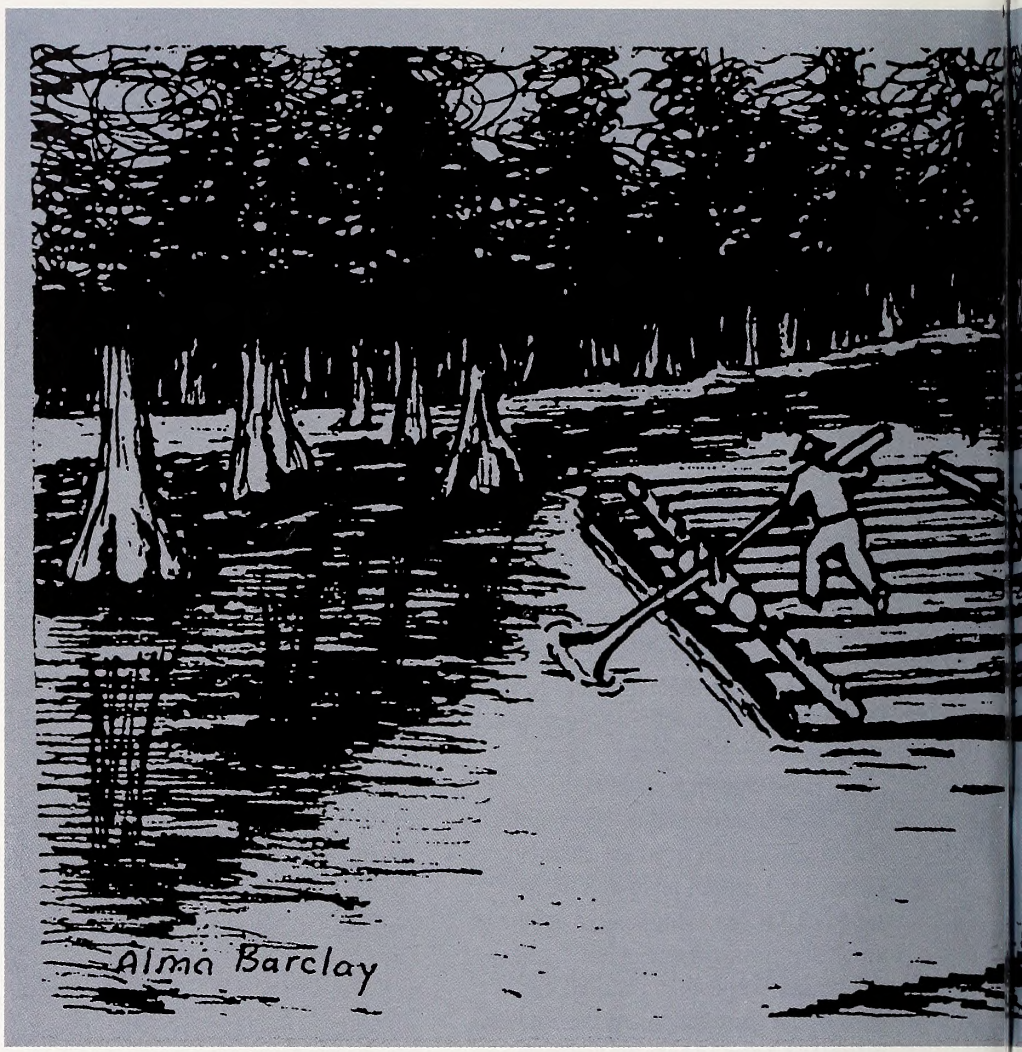
Continued

But these men also added a dose of cheer to river life. To combat their loneliness and to break the tedium of their downstream travel, runners would sing, whistle and holler, their voices echoing for miles through the river forests.

People, too, used the Black River for travel. Southeastern North Carolina was sparsely populated and roads were few and rough during Colonial times. The river provided an easy avenue for travel among plantations and the ports of Brunswick and Wilmington.

People not only traveled the river's length, but its width too. Several wooden-raft ferries were established to convey people across the Black River. The longest running and most famous was Corbett's Ferry, near present-day Ivanhoe. Only a matter of luck and some British reconnaissance prevented the Revolutionary War Battle of Moore's Creek from being the Battle of Corbett's Ferry.

Patriot forces under the command of Col. Richard Caswell took possession of Corbett's Ferry, awaiting the arrival of British soldiers commanded by Brig. Gen. Donald McDonald. The British bypassed the Patriots by crossing the Black River five miles above Corbett's Ferry on a makeshift bridge fashioned from a sunken flat. The Tories then proceeded to Moore's Creek for the now famous battle that ended British dominance in the area.



The steamboats that plied the Black River were double-deckers. The top deck was designated for passengers. Cargo — turpentine, tar, corn, wheat, cotton, cattle, turkeys or other marketable items — was loaded on the lower deck. The upper deck had separate passenger rooms and a dining area for meals. The cook, usually a woman, worked below in a kitchen, and a young boy was hired to haul food from the kitchen to the serving area. To supplement meals, captain and crew sometimes fished and hunted for game from the decks of the steamboats.

After the Revolutionary War, settlement along the Black River increased and the town of Lisbon (also spelled Lisburn and Lisborne) was built in 1785 at the head of the Black River where the Coharie and Six Runs rivers converge. Lisbon developed as a center for raft and pole boat activity and as a trading outlet for people who lived upriver.

With more settlement came increased use of the Black River for conveying goods, still mostly naval stores, timber and lumber. Canoes, rafts, periaugers and pole boats remained the primary means of conveyance until after the Civil War.

The first bridge, called Beatty's Bridge after its builder, was constructed in 1794. It spanned the Black River just below the intersection of the Black and South rivers. Other bridges were soon built.

Along the riverbanks, the construction of sawmills and gristmills, tanyards, naval store facilities and shipyards increased. The river hummed with activity during the early 19th century, but it didn't whistle.

The whistling steamboats that plied the nearby Cape Fear River as early as 1818 were too wide and heavy to navigate the more shallow, winding

Black River. After the Civil War, however, advances in engineering made it possible to build small, shallow-draft steamers.

Richard P. Paddison, a native of Harrells Store in Sampson County, pioneered the opening of steamboat traffic on the Black River in 1869 when he began operating the *Mary Eleanor* and *Little Sam.*

Little Sam ran between Point Caswell, a newly thriving Pender County town, and the port city of Wilmington. An advertisement in the *Wilmington Star* described the steamer's schedule and fares.

"The steamer Little Sam *is now running regularly between Wilmington and Point Caswell, leaving Wilmington Tuesdays, Thursdays and Saturdays at 11 o'clock a.m. and Point Caswell Mondays, Wednesdays and Fridays at 9 o'clock a.m., touching at all intermediate landings for passengers or freight. Fare $1 — meals extra. Freight charges very moderate. For freight or passage, apply to captain on board."*

Despite Paddison's advertising efforts, the *Little Sam* didn't prove profitable. Consequently, Paddison briefly diverted his interest to the Tar River, but returned to the Black River nine months later with the steamer *North East.* By now, Point Caswell had added a turpentine distillery, a sawmill and other commercial ventures that increased river traffic to the town.

Meanwhile, upriver trade of farming and naval store products grew, causing Charles Howe to place the *Little Adrian* in service in 1875 navigating the sunken logs, snags and flats of the upper Black River.

In the mid-1870s, a group of aspiring businessmen formed the Black River Navigation Company for the purpose of monopolizing steamer trade along the river from Point Caswell to its headwaters. The N.C. General Assembly granted the company exclusive rights of navigation for 50 years on one condition — the company must clear the upper river of submerged riffraff within five years.

The company did little or nothing to improve navigation of the upper Black River. The businessmen learned that trade along this portion was not as substantial as believed. Many small farmers and loggers were reluctant to trade their rafts, which cost nothing but time, for the more expensive steamer travel. And in no way did the company anticipate how hard it would be to clear the Black River.

Because of their inability and unwillingness to fulfill the contract, the Black River Navigation Company defaulted on its agreement, and the mo-

Continued

As steamboats approached a landing or town, the captain would signal its arrival with the blow of its whistle. Different whistles signified different cargo. This poem explains the designations.

One toot of the whistle,
steamboat's coming;

Two toots of the
whistle, freight aboard.

Three toots of the
whistle, a lady is coming
ashore;

Four toots of the
whistle, a corpse aboard.

Wood was needed to fire the boilers of the steamboats that traveled the Black River. Capitalizing on this need, river residents chopped cords of wood, leaving them stacked at landings along the river. Signs hung above the wood denoting its price. When a steamer began to run low on fuel, the captain would tie up at one of landings and all the deckhands and male passengers would disembark to help load the fuel. The captain would leave behind a note describing the amount of wood taken, and several days later he would receive a bill. If no stacks of wood were to be found when fuel ran low, the deckhands and passengers would chop what was needed from riverbank forests.

nopoly expired after five years.

Downriver at Point Caswell, Paddison was cooking up another Black River scheme. To bypass upriver entanglements, he figured to build a narrow-gauge railroad from Point Caswell to Clinton, passing through the heart of the forest that supplied vast quantities of timber and turpentine. At Point Caswell, the forestry products would be offloaded from steam train to steamboat for the downriver trip to Wilmington.

Paddison allowed his idea to languish for four years, then revived it with a vigor in 1881. He spurred leading businessmen in Sampson and Pender counties to solicit money for the project. In February 1883, the N.C. General Assembly issued a charter of incorporation for the Wilmington, Point Caswell and Clinton Railroad and Steamboat Navigation Company.

Although the railroad seemed a certainty, a competitor, the Wilmington and Weldon Railroad, approached Clinton businessmen about building a spur line from its main tracks at Warsaw to Clinton. Seizing upon this proposal, the people of Clinton reduced their support for the Point Caswell railroad.

To fight his opponents, Paddison cleared 10 miles of right-of-way at each end of the proposed line. But the action was to no avail as other supporters began to shift their support to the Warsaw-Clinton connection, which was completed in 1886. Had Paddison succeeded in his railroad-steamboat line, undoubtedly Point Caswell would thrive today and the history of the lower Black River would have been changed significantly.

As Paddison began losing ground on his railroad venture, he turned his attention back to the river itself, once again stamping his fingerprint on the river's history by initiating a push to improve navigation.

In 1883, he took newly elected U.S. Congressman Wharton J. Green upriver aboard the steamer *John Dawson,* pointing out the many impediments to travel along the way. After the trip, the citizens of Bladen, Pender and Sampson counties asked the congressman for an appropriation to clear the river, citing an annual transport of $750,000 in cotton, naval stores, timber, shingles and other commodities and suggesting that improvements could double that amount.

In response to the citizens' requests, Green sought an appropriation, and the U.S. Army Corps of Engineers sent Capt. W.H. Bixby to survey the Black River. His report provides insight into the river and its commerce. He writes: "The usefully navigable portion of Black River extends 36 miles from its mouth ... up to Point Caswell, a settlement of about 100 people."

Bixby noted that steamers regularly traveled between Point Caswell and Wilmington but that travel above Point Caswell to Lisbon or the small Sampson County town of Clear Run was restricted to periods when river waters ran high. Bixby also observed that despite 15 years of steamer operation, most of the products transported on the Black River were still carried by raft.

He counted 15 turpentine stills lining the riverbanks and, in his five days of survey, reported passing 620,000 feet of timber and 10,000 barrels of rosin either in transport or awaiting transport at landings.

Bixby recommended improvements to the river. First, he suggested clearing and channelizing only the lower river to Point Caswell. Then he amended his recommendations to include improvements all the way to Lisbon. In 1885, the federal government approved the project at an estimated cost of $33,500 and work was begun in 1887.

As companies schemed how to

In 1891, a large freshet sent the Black River beyond her banks. All the low-lying land was covered, and many people had to be rescued by boat. D.J. Black, one of the Black River's famous steamboat captains, rode the flood from upriver aboard his steamer Lisbon. *At places, the river's width stretched 2 to 3 miles, and Black lost the river's main channel, finding himself paddling over fields of corn. Noticing people on the roof of a flooded house, Black steered the* Lisbon *to their rescue. As he approached, one happy man was heard to say, "For Lord's sake! Yonder comes Noah's Ark." From that time on, the* Lisbon *was fondly nicknamed Noah's Ark. With some help from his newly rescued passengers, Black navigated his steamer back to the river.*

control the river and the federal government planned how to improve it, independent steamboat operators provided the service that kept the river thriving. In 1886, four steamers were operating on the Black River; the same number were plying the Cape Fear River between Fayetteville and Wilmington.

Although shallow-draft steamers continued to reach upriver to Lisbon and Clear Run during high-water months, travel was treacherous. But in November 1887, the *Wilmington Morning Star* reported that federal work on the river "has already made it possible for steamers to run regularly from this port (Point Caswell) to Clear Run, in Sampson County, on any stage of water."

Three years later, Capt. Charles Humphrey, the government engineer in charge of the Black River project, reported that commerce and steamer traffic on the river had increased. River trade, still principally naval stores, wood, cotton, rice and livestock, now totaled almost $1.2 million, and at least nine steamers, with names such as *Maggie*, *Frank Sessoms* and *A.J. Johnson*, operated at various times during the 1890s.

Federal work on the Black River ended in 1895. The project's budget had been substantially decreased as work progressed, and all planned improvements above Clear Run were deleted. The government did, however, approve a yearly $2,000 maintenance plan.

During this heyday of steamboat traffic, towns such as Point Caswell and Clear Run flourished and peaked in population. In 1884, Point Caswell boasted three blacksmith and wheelwright shops, three building and contracting firms, two turpentine distilleries, a wagon works, a shingle plant, a brick manufacturing facility, three mills, eight merchant firms, a school and one boarding house. And in its shipyards were built many of the steamboats that worked the river.

Upriver, Clear Run, population 65, supported a shipyard, a turpentine distillery, a cotton gin, three general stores and a large sawmill.

But as Point Caswell and Clear Run peaked, Lisbon died. With the demise of the railroad-steamboat plan and the failure of the government to improve navigation above Clear Run, the town's hope for expansion evaporated and people abandoned it. By 1895, Lisbon's population had dwindled to 25.

Perhaps Lisbon's death at the head of Black River spoke of things to come downriver. As the century turned with hope for the future, the ways of the past slowly faded away. The pine forests, once thought to be an unlimited source for naval stores, were drained dry. Railroads stole from the river its trade. And gasoline-powered tugs replaced whistling steamers as the workhorses of the river.

But even the tugs couldn't fight the lure of the highway and the mobility of the truck— the ultimate nails in the Black River's coffin of commerce.

Gradually the river quieted. Rafts no longer rode the currents. Sawmills no longer whined. Steamers were docked. Riverboat captains retired. Tugs moved to more prosperous locations. Point Caswell and Clear Run languished and died.

Some thought the Black River died too.

Economically, it did.

But in the Black River's demise as a commercial thoroughfare came the rebirth of a river guided not by the hand of man but by the whisper of nature.

People wanting to board a steamer or load it with cargo would signal boats in one of two ways from the many landings that lined the river. During the day, a white handkerchief was used to flag the steamboat. At night, lanterns, torches or large fires beckoned the riverboat captains.

Steamboats were notorious for one thing — boiler explosions. If their fires were stoked too high, the pressure in the boiler would become too great and sometimes explode. Such explosions were common on rivers such as the Mississippi and Ohio, and many passengers were leery of traveling aboard these hot-headed boats.

Only one such explosion ignited the history of the Black River. The Delta *exploded at 2:30 a.m., April 19, 1887, three miles above Point Caswell at Patrick's Landing, awakening people for several miles up and down the river. When the* Delta *passed the Point Caswell bridge tender only 30 minutes before, her angry captain was heard to say: "I'm going to be at the Delta (Landing) by daybreak or I'll blow her to hell."*

And that he did, killing a fireman and a deckhand. As a testimony to the tragedy, story has it that a tatter from the fireman's shirt hung in a nearby cypress tree until it rotted away, and the twisted boiler remained lodged in the swamp until it was claimed for scrap metal during World War II.

Sources for this story included:
The Lower Cape Fear in Colonial Days by Lawrence Lee,
Riverboating in Lower Carolina by F. Roy Johnson,
The Heritage of Sampson County, North Carolina published by the Sampson County Historical Society,
An Historical Overview of the Black River in Southeastern North Carolina by Wilson Angley.

Old Forests May Be Last Refuge For Rare Bat

The Black River forest grows in ancient isolation.

Few places in North Carolina can compare to its swampy beauty. And few places are a better habitat for the rare and possibly endangered eastern big-eared bat.

Researcher Mary Kay Clark has searched 10 years for this bat, uncovering colonies on the Black River and in other mature swamp forests in North Carolina and Virginia. Her findings may cast new light on the importance of this unique wooded habitat to cavity-dwelling creatures.

By Jeannie Faris

An eastern big-eared bat is fluttering through the nighttime woods, foraging for moths to eat. Its body is small and furry; its wings, soft and crepe-paper thin. Its tiny round head is dwarfed by a pair of towering, pointed ears.

The bat is like most of its species, with one exception. It has lost its gift of stealth to a chemiluminescent bulb glued to its back, giving it the appearance of a giant, weaving firefly.

This light tag makes the bat visible to a nearby observer, who broadcasts its erratic flight pattern over a walkie-talkie, at the same time recording its actions for a North Carolina research project.

The observer notes that the bat is cutting a lighted zig-zag pattern over and through the forest foliage. It soars high and low again like a boat riding

ocean swells. It flies slowly, compared to other bats, and seems to hover in places. Quite possibly, the bat's big ears are listening for a moth's wingbeats or echolocating its position by sounding high-frequency notes that boomerang off the prey. Working like radar, these ears are thought to help track its next meal.

About 20 observers are staked out in these woods and on a nearby river, watching and listening, each waiting his or her turn to report on the lights that approach one at a time.

"I see the bat has landed about a meter from the ground," says one.

"(It) dipped (to) the water three or four times," reports another.

"The bats are in the tree ... I can see a light flashing down in the base of the hollow ... ."

This elaborate setup begs the question, why so much fuss over a bat? Bats, after all, have been cast the villain by centuries-old folklore.

In truth, this bat is harmless, unless you're a moth.

It doesn't even look dangerous, with wide-set eyes and a small mouth that conceals sharp teeth. Its expression is placid compared to other ferocious-faced bats with bigger, more prominent teeth for biting down on beetles and hard-bodied insects. It is mouselike, gray-brown with a light underbelly. Two large lumps protrude from its snout, although no one really knows why. Its giant ears, tall and ribbed when erect, curl ramlike along its head to conserve body heat when it rests. Long hairs grow between its toes.

For a different point of view, however, talk to Mary Kay Clark, curator of mammals at the N.C. Museum of Natural Sciences. She sees this bat as more than a composite of its less-than-beautiful parts. On the contrary, she says, all bats are fascinating creatures with countless strange facial adaptations to help them along in life.

Merlin D. Tuttle, Bat Conservation International

The eastern big-eared bat of the coastal plain has been found roosting in abandoned buildings and old, hollow trees.

On two hot July nights in 1988, Clark and her research recruits had the eastern big-eared bat under surveillance. The mission of their forest stakeout was to pry loose a few closely guarded secrets of the reclusive and possibly endangered *Plecotus rafinesquii*.

One by one, they light-tagged 27 bats outside their roost and released them into the woods for a rare glimpse at how they seek out food and shelter. Clark then pieced the information into the complex puzzle of this bat's habitat needs.

Years of study have given the puzzle shape. The pieces still missing might be found in old forests akin to those on the Black and Yeopim rivers.

Clark believes the bat once roosted and foraged widely in these and other mature forests in North Carolina. But with the decimation of the drier upland woods, the only remaining refuge for this bat may be the old swamp forests, a unique and perishing habitat. She wants to know if the bat still lives in tree hollows there. If so, her findings can guide the level of habitat protection, if any, the bat needs.

To date, however, only four tree roosts are known for this bat in the

Continued

North Carolina coastal plain. Most are near the Yeopim River in Chowan County, discovered by volunteer Paris Trail of Edenton. Otherwise, the bats have been found living in abandoned buildings, hanging from walls and rafters, along portions of Yeopim River and the Black and Cape Fear rivers in Bladen County.

Clark focused on these areas because the bat seems to prefer swampy, undisturbed habitats that resemble the forests it enjoyed before development and logging pressures set in.

"These happen to be areas where there are still some mature forests that contain trees with extensive cavities," she says. "And I think these bats require that kind of habitat. Mature forests are rare and are disappearing very rapidly. Even with wetlands regulations, there's still a lot of pressure on mature forested wetlands."

The eastern big-eared bat lives throughout the southeastern United States, from the Dismal Swamp in Virginia south and west through the coastal states to eastern Texas. It is known from southeastern Oklahoma and western and southern Arkansas up the Mississippi River Valley to southern Illinois, southern Indiana and western Kentucky. Isolated populations have also been found in southern Ohio, eastern Kentucky, Tennessee and central West Virginia.

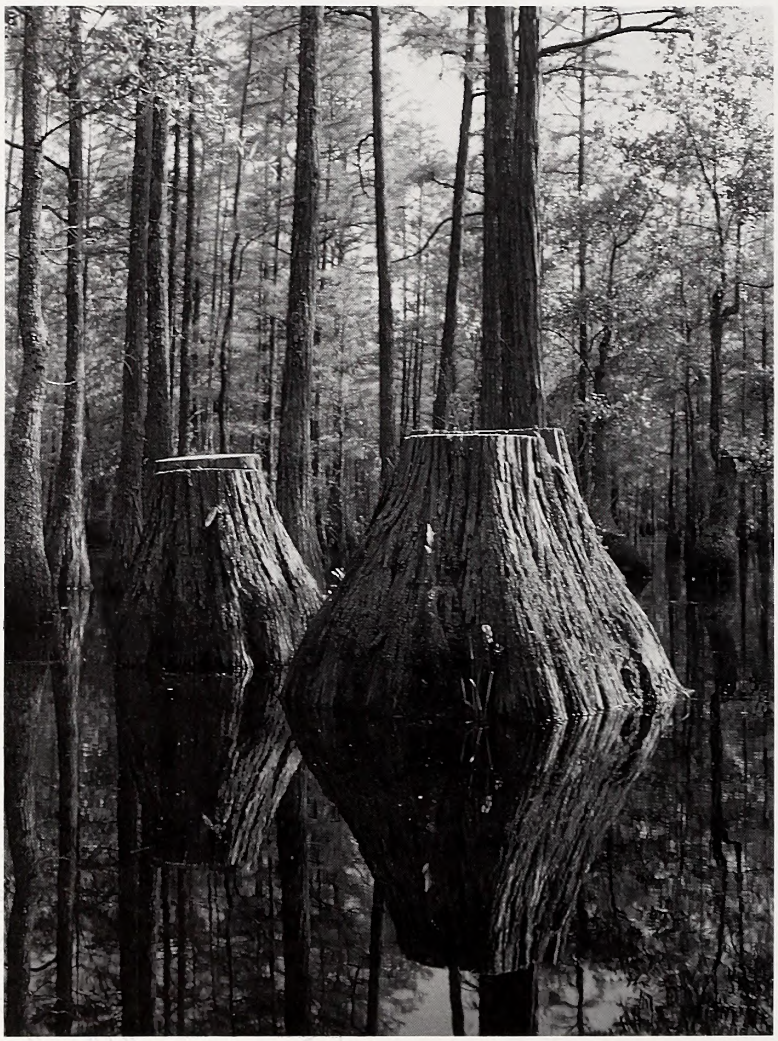
But few records of this bat are available in most states within its range.

In North Carolina, it went unsighted for most of the first half of the 20th century, Clark says. A few sightings in the 1960s broke the 50-year dry spell, but its numbers are thought to be declining.

Today, it remains one of the nation's least understood bats.

Not for lack of trying, however.

David Lee, N.C. Museum of Natural Sciences



The bat appears to live in small colonies in old swamp forests, but the future of this habitat is uncertain. These cypress stumps were cut in Bladen County.

Clark has invested 10 years in bringing to light the lifestyle of this bashful, nighttime creature. Unlike some bats, it is shy of people and activity. It lives quietly in the coastal plain where the critical combination of water, forest cover and suitable roost sites occur close together.

Clark's search for the ambling forest bat had simple beginnings. She knew it was rare. So she began in 1984 by looking for it in old, abandoned buildings in Sampson and Bladen counties as she drove from Raleigh to visit her parents in Elizabethtown. There were records of it in Bladen County from the 1960s, so chances were good that she'd find some.

The inspections of old buildings paid off. Her flashlight began to fall on nursery colonies of adult females and their offspring, usually born in late May and early June. The solitary, smaller males were found living apart from the colonies in the summer. By fall, however, the males merge with the females and young to hibernate through the winter.

Encouraged by her early findings, Clark resolved to drive every road in Bladen County, systematically searching for bats in abandoned buildings. This intensive inventory gave her an eye for what passed as a good "bat house." And she learned that if she looked hard enough in the right places, she could find these bats where they hadn't been spotted in decades.

"We found the big-eared bats, and we found quite a few of them, compared to having nothing," she says. "But when we were finding them, the colonies were small, very small."

In the meantime, Trail was coming across the bats roosting in old buildings as he rummaged through Chowan County woodlands. But this avid naturalist and wildlife photographer, retired from New York state, had never before

seen such a bat. His inquiries led him to Clark, and he joined her efforts to broaden the emerging picture of this bat's habitat.

"We began checking trees," says Trail, also known as "bat man" around Edenton. "I guess I've looked in more hollow trees than anyone in North Carolina."

Over the years, Trail has been involved in all of Clark's Chowan County studies, and he was the observer who discovered light-tagged bats ducking into a tree cavity as they foraged. His interest in the bat has taken him slogging through acres of swamplands in search of old tree cavities, which are checked for inhabitants, measured and marked. He was on hand in 1992 when Clark and other research recruits marked 150 hollow trees in Chowan County, particularly black gum, sycamore, sweet gum and tulip poplar. Another 50 trees in Bladen County were inspected with mirrors and flashlights the same summer.

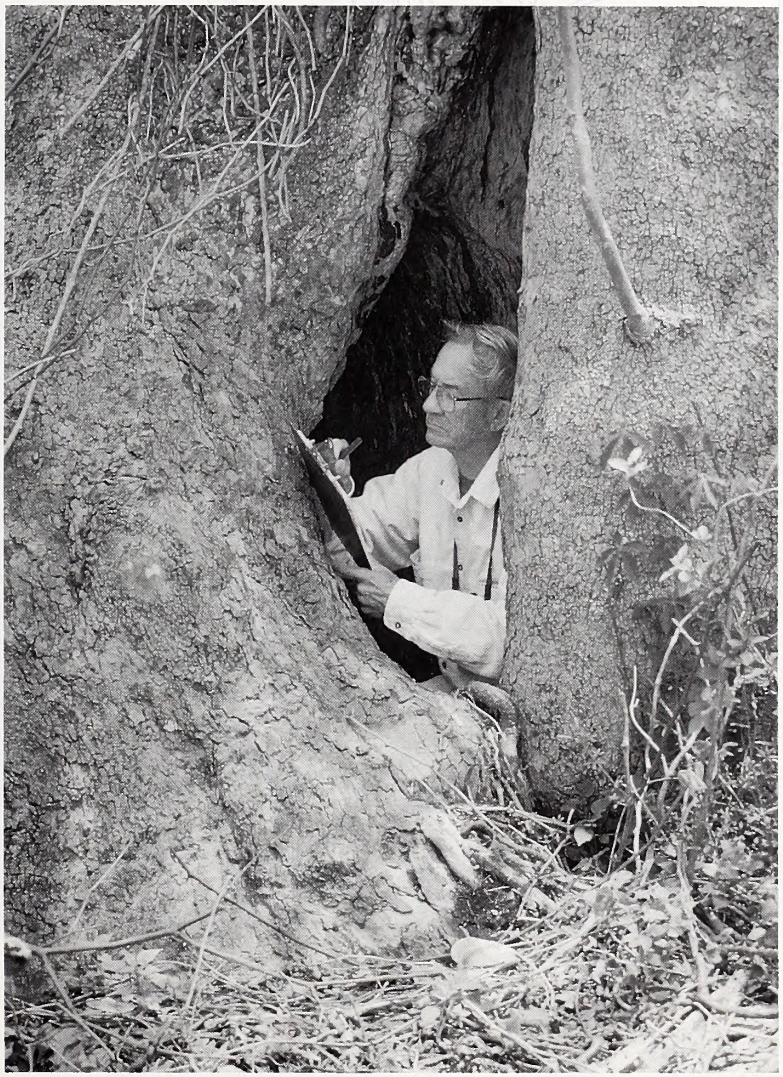
"We get real excited when we find a bat living in a natural hollow," Trail says.

Without this layman's brand of enthusiasm for the bat, Clark might have trouble convincing volunteers to spend entire summer nights in a swamp and to crane their heads into dank tree hollows.

But the work is important to more than a handful of bat enthusiasts. Clark's research in North Carolina and Virginia — as well as studies in Kentucky, South Carolina and Arkansas — is critical in determining what protection the bat might need, says Bob Currie, a biologist for the U.S. Fish and Wildlife Service.

"That bat is declining probably because of loss of habitat — roost habitat and foraging habitat alteration," he says. "Most of our bats have had trouble with roost sites because of either disturbance of caves or loss of roost trees."

Mary Kay Clark, N.C. Museum of Natural Sciences



Paris Trail takes notes in a Chowan County tree hollow where a male bat has made his roost.

The eastern big-eared bat was listed nationally as a Category 2 species of concern in September 1985, meaning there is reason to believe its population may be declining. But there's not enough evidence to make an airtight case that it is threatened or endangered, which would land it on the short list of Category 1 animals. The Fish and Wildlife Service lists a species as Category 1 when research proves conclusively that its numbers are in jeopardy, Currie says. Then, it's just a matter of time and procedure before it is officially an endangered species.

Already, seven of the nation's 43 bat species are known to be federally threatened or endangered in all or parts of their range. And nearly 40 percent of North American bat species are listed as endangered species or candidates for that status, says Robert Benson of Bat Conservation International, a nonprofit organization.

The eastern big-eared bat remains a candidate. It is on a waiting list of sorts with about 1,670 other Category 2 animals that may or may not be proven eligible for the federal endangered species list.

In the meantime, these species get no federal protection. And funding is scarce for the research that is so critical to learning their status. But perhaps other benefits go unmeasured and underestimated, particularly the higher profile that these animals enjoy in their home states.

"Making a designation like that may give the animal some degree of protection, but it also alerts biologists to the need for study and helps to direct research," Clark says. "Individual states may give the bat a certain

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amount of legal protection, but probably the primary benefit of the Category 2 listing is that it gets the word out that biologists need to start looking at the needs of this bat or to initiate surveys for this bat."

Each state can craft its own laws to safeguard native plants and animals beyond the federal protections. The eastern big-eared bat has benefited from this recognition, though piecemeal, throughout its range. Every state it lives in has listed the bat in some category of concern.

In North Carolina, the big-eared bat and other nongame species are protected by the 1987 N.C. Nongame Act. This law makes it illegal to take, collect, possess or kill certain nongame species without a permit, which is usually issued for research or education, says Randall Wilson, section manager for the Division of Wildlife Resources' Nongame and Endangered Wildlife Program. This program also offers small grants that have funded some of Clark's research in North Carolina.

To the north, Virginia took the step of declaring the bat endangered in July 1987, making it illegal to harm or harass the bat or to modify its habitat to the point that it will be harmed, says Karen Terwilliger, a biologist for the Virginia Department of Game and Inland Fisheries.

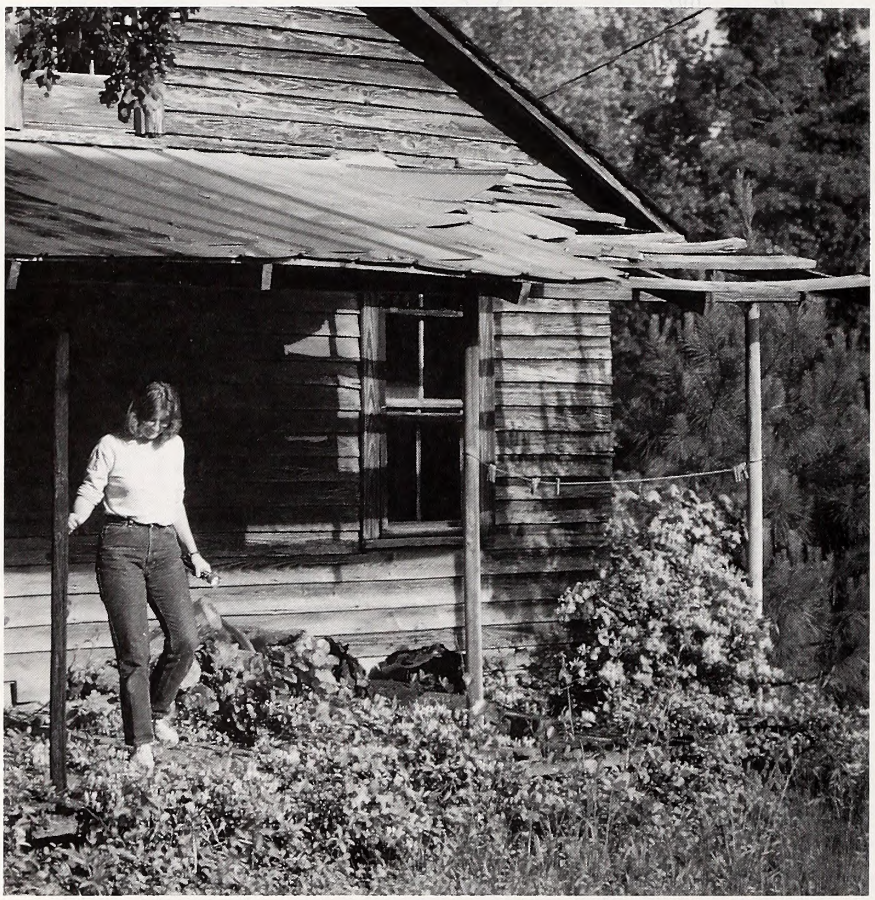
At the time, the bat was thought to be on the brink of disappearing, if not already gone, from its historic home in southeastern Virginia near the North Carolina border. It had been sighted in these forests only a few times in the previous 100 years, Terwilliger says.

Clark proved otherwise in 1993 with a survey of the region that found 24 new roosts with 56 bats.

"Within those borders, they had so few records," she says. "It looked like that bat wasn't even there anymore because for about a century, they didn't have any new records."

But she knew, based on her North Carolina research, that bats were probably more widespread in Virginia than thought. Her efforts in both states proved colonies existed, but their numbers were small. So the question remains, are these small populations north and south of the border stable or declining?

David Lee, N.C. Museum of Natural Sciences



Researcher Mary Kay Clark inspects an abandoned "bat house" that is typical of most roost sites chosen by eastern big-eared bats in the coastal plain.

The answer, in part, lies in knowing more about their tree-roosting habits. Clark believes that mature forests are critical roost sites for these bats, and she wants to know how strong that connection is. She wants to know whether an uncounted population is living in tree cavities.

The fact that only a handful of tree roosts has been found doesn't necessarily mean that the bats prefer manmade structures, Clark says. Colonies are simply harder to find there. And peering into dark hollows with mirrors and flashlights is a neck-breaking way to locate them.

There is a better way, called radiotelemetry. Other researchers have successfully used this technology to study the habitat needs of bats, and Clark hopes to use it this summer to find more tree roosts.

The technique calls for gluing transmitters onto bats caught in mist nets while they're searching for food. For about 10 days, the transmitter gives off a signal that researchers can trace to the roost in the daytime and foraging grounds at night. Then it falls off.

"The goal is to learn more about how they use the forest and to locate more tree cavity roosts. With that information, we can predict where they may be and how developmental pressures will affect populations of tree-dependent species like the eastern big-eared bat," Clark says.

In the meantime, she will continue

this year tracking and possibly light-tagging in the Francis Beidler Forest, a part of Four Holes Swamp in South Carolina. This forest contains 1,700 acres of virgin bald cypress trees, the largest such stand in the world and home to a variety of bats and cavity-dwelling birds, says Norman Brunswig, assistant sanctuary manager for the National Audubon Society.

Brunswig is anxious to know if the eastern big-eared bat is among the animals there. If so, it could provide an indispensable new tool in the effort to preserve and foster respect for the old-growth forest habitat, he says.

"We are trying to make the case that very big, old trees are a very valuable part of the biodiversity of the earth," Brunswig says. "If we want to make really big contributions to biodiversity, we have to preserve large blocks of all kinds of habitat."

Still, the bat's taste for old trees and buildings may complicate its future, Currie says. Many of these areas are privately owned and already in jeopardy of vandalism and natural deterioration.

"If it's added to the federal (endangered species) list, habitat would be one of the things that we'd address first," Currie says. "But how you look at that is difficult. Trees are privately owned, and the abandoned buildings are privately owned or deteriorating on their own. They're old or they burn. It would be a difficult problem to deal with."

Mary Kay Clark, N.C. Museum of Natural Sciences

The bats are often found hanging from rafters or walls in abandoned buildings that are sited near woods and water.

In Chowan County, an old schoolhouse that harbored a bat colony 350-strong has been demolished, Trail says. He doesn't know where these bats went.

This incident and others like it give weight to the argument that timing is critical.

Roosting and foraging habitat for forest bats are thought to be in jeopardy, Clark says, and conservation efforts are difficult to plan without sufficient knowledge of their habitat needs.

"I have a real fear that if we don't learn more about their habitat needs soon, it might be too late. The big-eared bats may occur in healthy numbers now, but there is an awful lot of pressure on mature forests, and these areas are probably critical to their survival, she says.

"In general, we need to learn more about the species that depend on that kind of habitat in order to develop management plans for preservation and conservation of mature forests. The approach in the past has been crisis management — spending a lot of time and money to save a single species. If we take actions to protect biological diversity, we can do the same thing and ensure that species like the eastern big-eared bat are around for a long time."

BAT CONSERVATION INTERNATIONAL

Bats are major predators of night-flying insects, and they pollinate flowers and disperse seeds in ecosystems from rain forests to deserts. Some are essential to other animal and plant species. Yet despite their importance, they are among the world's least appreciated and most endangered animals.

Bat Conservation International is recognized as the international leader in conservation and education initiatives that protect bats and their habitats. For more information about bats in your own back yard or far-flung lands, contact BCI at P.O. Box 162603, Austin, TX 78716 or call 1-800/538-BATS.

Golf Courses: Do They Handicap Water Quality?

The trappings of a strong coastal economy are often measured in restaurants, resorts and retirement homes. But the sand-filled traps of golf courses are becoming another yardstick of prosperity.

Close to 60 of the 500 golf courses carpeting North Carolina soil are in the coastal region. Their acres of sculpted green courses, often the centerpiece of new resorts, attest to the popularity of the sport and the attractiveness of our coastline as a resort area.

But they also raise questions about the environmental damage caused by golf course construction and maintenance, especially to water quality. The chemicals used to maintain turfgrass can contribute nutrients and other pollutants to nearby surface waters and groundwater. Coastal waters logged with nutrients can experience algae growths, which consume oxygen and sometimes kill fish. Pesticides can contaminate drinking water, fish and shellfish, threatening the health of humans and the environment.

When compared to other urban development and agriculture, golf courses are a fairly small source of these chemicals. Nonetheless, they contribute. And it's important to identify and control all pollution sources that are degrading our coastal waters.

So exactly how much pollution do golf courses contribute to coastal waters and how can this be avoided?

Location

Resort golf courses are expensive to build, often approaching $5 million before they're completed. And investments of this size are built with an ideal location in mind. Many coastal golfing developments are located next to picturesque wetlands, streams and estuaries. Sometimes they're next to shellfish waters.

Once a site has been selected, the construction of the course itself can have the greatest impact on nearby waters. Sediment rinsed from construction can smother juvenile fish, shellfish, plants and invertebrates. And bacteria from the housing and commercial development associated with the golf course can contaminate nearby shellfish beds, forcing their closure to protect human health.

Many problems can be avoided in the design by minimizing land disturbance, leaving large vegetated strips of land between the course and surface waters, phasing the construction to minimize exposed soil area, and outlining an erosion-control plan that assures sediment will not leave the construction site. Or, rather than altering pristine areas for development, land-use planners could encourage the siting of golf courses in areas already degraded or developed.

Chemical Management

Turfgrass management is the most highly refined agricultural practice that requires the use of fertilizers and pesticides to maintain a thick, healthy stand of grass free from disease and pests. The intensity of this management — and consequently, the amount of pollutants that leave the course — is decided largely by members and golfers.

On average, only about 60 acres of the 160-acre playing area — including the greens, tees and fairways — are routinely fertilized and treated for pests.

Once these chemicals are applied to the course, they can take various paths into the air, water or soil. They can be absorbed by the turfgrass, vaporized into the air, leached into the soil or washed off by rain. Chemicals that run off the course after a rain or leach through soil en route to groundwater pose the greatest threat to water quality.

But a direct link between golf courses and water quality degradation is tenuous at best because so little information is available. Until recently, there were few studies of how pesticides and nutrients move from golf courses. More information will be available soon from environmental studies conducted at universities across the country with funding from the U.S. Golf Association.

The limited research available suggests that proper management can minimize leaching and runoff of pollutants into surface waters and groundwater. Scientists continue to develop new strategies to reduce the use of chemicals and limit their movement from golf courses. For instance, course superintendents can use slow-release and low-level fertilizers, correlate fertilizer applications with plant needs, test the soil to identify lacking nutrients so that unnecessary fertilizers are not applied, irrigate conservatively, select disease-resistant grasses, use integrated pest management to apply pesticides only when needed, use natural predators to control pests and build ponds on the course to detain runoff and allow time for natural processes to remove nutrients and pesticides before they enter nearby waters.

Many measures have been tested and proven effective. Now the most important job is to encourage golf courses to use these measures.

Other Sources

Although golf courses are a source of chemicals, nearby water quality degradation can't always be traced directly to turfgrass.

Sometimes it's hard to separate chemicals from a course and those washed from the homes that may accompany it. The same fertilizers and pesticides used on golf courses are applied to private lawns and gardens by homeowners who have little or no knowledge of proper chemical use. Homeowners, as well as golf course managers, must properly manage lawns to protect water quality.

For more information, write N.C. Sea Grant and ask for the winter 1994 issue of *WaterWise*. Or contact your local cooperative extension office.

Barbara Doll, N.C. Sea Grant coastal water quality specialist

Conflict or Consensus Between Anglers and Watermen?

Conflicts are inevitable when people compete to achieve or reach the same end. In coastal North Carolina, conflicts over using or harvesting resources are heating up as more people vie to catch the same fish, use the same water or occupy the same beach.

Nowhere are coastal conflicts more visible or audible than in the arena of commercial and recreational fishing. The two groups are verbally tussling over issues such as bycatch, the rights to certain fishing grounds, catch limits/quotas and gear restrictions.

Sometimes the disagreements are quietly stated; other times, as in the case of a recent dispute over fishing rights to The Point at Hatteras Island, tempers flare and the exchange becomes more heated.

Each group tries to wield political power, and each boasts of its economic importance to the coastal economy.

Caught in the middle of these feuding factions are management agencies such as the N.C. Division of Marine Fisheries and the South Atlantic Fishery Management Council. They must alleviate the pressures that sometimes build as recreational and commercial fishermen square off.

But how do they resolve these conflicts? Are these strifes real or just perceived? And how many of the disagreements are based on misinformation and rumor?

To examine conflict between recreational and commercial fishermen, Sea Grant researchers David Griffith and Jeff Johnson went straight to the source — the fishermen themselves. These East Carolina University social scientists wanted to determine the basis for disagreement between recreational and commercial fishermen and what, if any, common ground existed.

The social scientists also wanted to learn if there was consensus within each group. Do all sport anglers and all commercial watermen concur on what the problems are?

First, Griffith, Johnson and their graduate students spent hours interviewing representative fishermen from both groups, asking them about the major resource problems along our coast. Based on these interviews, the research team chose 59 statements that represented recurring coastal problems mentioned during the interviews.

The statements, written in the fishermen's own words, were listed on a survey form and sent to more than 230 anglers, resource managers and watermen. The anglers were asked to read each statement and indicate whether they agreed or disagreed with it.

The survey included statements such as:

- Fish populations have been declining since the 1960s.
- Trawling should be limited to the ocean only.
- Regulations are forcing commercial fishermen out of business.

Between 50 percent and 60 percent of the fishermen surveyed returned their questionnaires; then Griffith and Johnson analyzed the responses.

They learned that no consensus existed between commercial and recreational fishermen, but within each group consensus did occur. However, sportfishermen tended to agree more with one another than did commercial watermen. Johnson says that conflict within the commercial fishing community over gear use tends to make them less homogeneous than their recreational counterparts.

Of the 59 statements presented, commercial and recreational fishermen disagreed on 32. There was, however, common ground. The two groups did agree on 12 statements.

Generally, Griffith and Johnson found that commercial fishermen assign problems to natural cycles, tourists and pollution. Sport anglers, on the other hand, assign problems to commercial harvest, although they also recognize that water quality problems and natural fluctuations have roles.

Each group thinks the other is more cohesive and powerful and receives special attention from managers and legislators.

Much of the agreement between watermen and anglers concerned management. Both factions agree on the following:

- There should be limits placed on who can sell fish.
- Everyone should contribute to the cost of management.
- Both groups have members who abuse the resources.
- Everyone should have access to the resources.
- Everyone should be regulated.
- There should be some limitations and restrictions on trawling.

Griffith says the team's findings should be helpful for resource managers.

It will differentiate real conflicts from perceived ones. Strife based on perceptions can be resolved easily by providing accurate information to opposing groups. The research will also show how conflicts reflect political and social alliances, thus identifying key groups of people who need to be involved in solving frictions.

Kathy Hart

Information Highway

The *Coastwatch* staff is chugging along the information highway these days. If you would like to contact us via Internet, please use the following address: k_hart@ncsu.edu. Use your computer to fill our electronic mailbox with letters to the editor, comments about the magazine, story suggestions or queries about our coastal habitat.

Sound Facts

N.C. Sea Grant and Year of the Coast are working together to send North Carolina coastal newspapers a weekly information-and-graphic box called Sound Facts. Each box will feature brief, factual information about North Carolina's coastal and marine resources. And to catch the eye of readers, these educational tidbits will be attractively illustrated with graphs and line drawings.

Sea Grant and Year of the Coast want to help newspapers educate readers about the value of our coastal environment. Both organizations feel that a better educated populace means better coastal stewards.

When presented with examples of Sound Facts, coastal newspaper editors were enthusiastic about the effort and most committed to placing the illustrated boxes within the pages of their newspapers.

Look for Sound Facts in your newspaper.

Gambling with Zebra Mussels – Mid-Atlantic Conference

Mid-Atlantic states have kept a watchful eye on the zebra mussel's destructive passage through the Great Lakes and waterways south.

But eight years after the mussel arrived in Lake Erie, the mid-Atlantic states are ready to do more than watch and wait for it to invade their borders. An upcoming conference sponsored by the mid-Atlantic Sea Grant programs will guide the process of assessing the risks and preparing for an invasion.

"Gambling with the Threat of Zebra Mussels in the Mid-Atlantic" will be held June 1-3 in Atlantic City, N.J.

The conference will help managers of natural resources and water-dependent industries learn to assess their risks, monitor and develop controls to keep the mussels at bay, says Barbara Doll, N.C. Sea Grant's coastal water quality specialist.

Targeted groups include lake managers; state and federal water resource agencies; and managers of industries such as water treatment, pulp and paper, aquaculture, power generation, golf courses and agribusiness. Educators, too, can hear the latest about zebra mussel biology, impacts and movement.

The mussels were inadvertently delivered to United States waters around 1986 in the discharge of European shipping ballast water. Colonization of water-intake pipes, boats, docks, piers and other structures in the Great Lakes region has already cost millions of dollars. Some speculate it's only a matter of time until they spread throughout the United States.

If they colonize the mid-Atlantic, the zebra mussels could interfere with municipal and industrial water-users, sport and recreational fisheries, food webs, navigation, recreational boating and beach use.

Doll will attend the upcoming conference. For more information, call her at 919/515-5287. Or contact Eleanor Bochenek of New Jersey Sea Grant at 908/349-1152.

The Sea Grant programs of the mid-Atlantic include North Carolina, Virginia, Maryland, Delaware, New Jersey and New York.

Biotechnology: Combating Marine Pathogens

Many viruses and bacteria can contaminate aquatic animals and make humans ill. Other pathogens, which cause disease in fish and shellfish, are responsible for killing large number of animals in natural fisheries and aquaculture operations. Although some of these pathogens are indigenous, others are present because of pollution.

Sea Grant scientists are taking several paths to solve the problems of marine pathogens.

In North Carolina, Alabama and Louisiana, Sea Grant researchers are working on rapid and sure analyses to identify pathogens in seafood. Using DNA technology, they are developing practical methods to detect Hepatitis A virus and *Vibrio* and *Salmonella* bacteria that can be filtered by oysters and clams from polluted waters. Rhode Island Sea Grant researchers are taking a different approach with antibody technology to directly detect pathogens in seafood.

At California Sea Grant, scientists are honing their ability to precisely identify polluted coastal waters so that bans on fishing and recreation can be restricted to the smallest possible areas. They are trying to use gene probes to profile the bacteria and viruses that live in unpolluted waters. These will be compared to profiles of waters polluted by sewage, stormwater runoff and harbor discharges.

To prevent the spread of disease and ensure the use of healthy stocks in aquaculture, Sea Grant scientists in North Carolina, Maine, Minnesota, New York and Oregon are developing diagnostic tests for several diseases.

Sea Grant programs are also researching ways to counteract pathogens in natural fisheries. Dermo and MSX are parasitic diseases that have injured the North Carolina oyster industry and almost destroyed it in the Chesapeake Bay. To control a parasitic disease, its natural history and its cellular interactions with hosts must first be determined. Maryland and Virginia Sea Grant scientists recently took a major step in this direction by developing a technique to culture pure, reproductive strains of the Dermo parasite in the laboratory. The new culture technique is expected to be a key to defining

Dermo's infective processes and devising a strategy for protecting oysters from it. Other researchers in Maryland and Virginia are working on practical methods to introduce MSX-resistant oysters to the bay.

As Sea Grant develops new technologies that will ensure public safety, it is advancing the molecular sciences and applying state-of-the-art technology to solve problems that inhibit aquaculture and use of fishery resources. Sea Grant will continue this area of marine biotechnology research with $3.2 million of new National Oceanic and Atmospheric Administration funding in 1994.

Research on Shrimp Production

Americans imported nearly $2 billion worth of shrimp in 1992, landing seafood as a major contributor to the U.S. trade deficit.

But Sea Grant is working to slow this trend toward farm-raised imports by expanding aquaculture opportunities that will produce more shrimp in the United States.

Already, aquaculture research by Sea Grant programs across the country has provided a basic level of technology that has helped open shrimp farms in Hawaii, Puerto Rico, South Carolina and Texas. But these farms have been only marginally successful because disease, poor understanding of nutritional requirements and inappropriate temperatures for year-round growing have caused inconsistent production.

The problem would be eased by a completely domesticated strain of shrimp that is adapted to United States growing conditions and has superior commercial qualities.

To this end, a group of scientists came together for a recent Sea Grant workshop to determine future directions for hormonally controlling the reproduction and growth of crustaceans. They agreed there are many tools for producing a truly domesticated shrimp and developing improved strains for the commercial industry.

Sea Grant is now focusing its research efforts on solving the problems of inconsistent production. Gene probes are being developed for two significant viral diseases that limit shrimp production in several parts of the world. This work will also help researchers identify disease-free parental stock, called brood stock, and open the door to "specific pathogen-free" shrimp stocks for the industry.

Other Sea Grant researchers are perfecting closed recirculating culture systems that would allow improved shrimp species to be grown in the United States.

Melding the domestication of shrimp with competitive production technology requires an intensive, coordinated effort by researchers, universities and federal agencies. Sea Grant can focus these aquaculture resources on common goals. Plans are now under way to unite researchers in a new national effort to develop domesticated shrimp stocks suitable for growing in different systems.

Celebrating Coastal Traditions

Thousands of folks will gather in Raleigh April 16-17 to celebrate the beginning of a new year — The Year of the Coast. The Save Our Sounds Coastal Celebration is the the kickoff event for this special yearlong showcase of North Carolina's coast, proclaimed by Gov. Jim Hunt.

For the past five years, the Coastal Celebration has educated thousands of people about North Carolina's coastal treasures, how they are threatened and how they can be protected. With the state reviewing 20 years of its coastal management program and Hunt placing new emphasis on safeguarding coastal resources, the 1994 Coastal Celebration is more important than ever.

This year's theme is: "Year of the Coast ... For the Children." Activities for children will include a touch tank of live marine creatures and storytelling. An array of educational materials will also be available for teachers to keep the message alive in the classroom.

People of all ages can enjoy demonstrations and displays by boatbuilders, artists and craftspeople who live along our beaches and sounds. Visitors will also experience the offerings of masterful coastal cooks.

Coastwatch and N.C. Sea Grant will be there too with an educational display and staff to answer your questions about marine and coastal resources.

The event will open both days at 10 a.m. in the Kerr Scott Building on the N.C. State Fairgrounds. Doors close at 6 p.m daily. Admission is free for children; adults are asked to donate $2 at the door.

Fish Banks Ltd.

N.C. Sea Grant, the N.C. Department of Public Instruction and the National Dissemination Network are joining forces at an innovative teacher workshop at N.C. State University.

The training workshop, scheduled for April 23, revolves around Fish Banks Ltd., an educational program designed to teach fundamentals of fisheries resource use and management. Fish Banks is a simulation game in which teams form commercial fishery businesses with vessels to harvest inshore and offshore stocks. Through this game of economics and natural resource utilization, participants learn firsthand about risk and investment.

"Fish Banks is a good game to help all of us — whether we're students, teachers or policy people — understand some of the psychology and decision-making of the commercial fishing industry," says Sea Grant marine education specialist Lundie Spence.

The curriculum is designed for teachers of students from ninth grade through undergraduate college level and adult audiences. Materials include a game board, tokens, computer program (Macintosh or disk operating system) and handouts.

Fish Banks developer Bob Burnette-Kurie will conduct the workshop, which is scheduled for 9 a.m. to 3:30 p.m. in Jordan Hall, Room 1108. A North Carolina fisheries biologist will be available during the training to relate current developments in fisheries issues.

The cost of the workshop is $5; preregistration is required, and space is limited. For information, call Spence at 919/515-2454.

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, N.C. Sea Grant supports several research projects, a 12-member extension program and three communicators. B.J. Copeland is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

Coastwatch (ISSN 1068-784X) is published bimonthly, six times a year, for $12 by the North Carolina Sea Grant College Program, Box 8605, N.C. State University, Raleigh, NC 27695-8605. Telephone: 919/515-2454. Fax: 919/515-7095. E-mail: k_hart@ncsu.edu. Second-Class Postage paid at Raleigh, N.C.

POSTMASTER: Send address changes to *Coastwatch*, N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Front cover photo of horses running on Shackleford Banks by Scott D. Taylor.

Inside front cover photo of Shackleford Banks horses by Scott D. Taylor.

Printed on recycled paper by Highland Press Inc. in Fayetteville, N.C.

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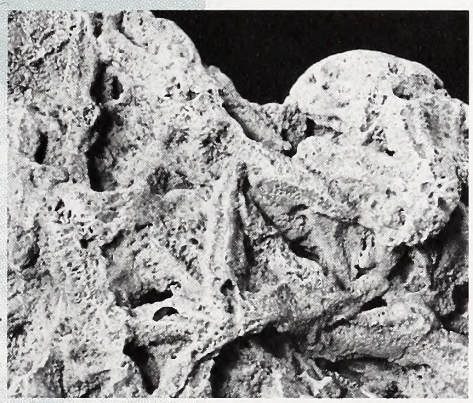

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From fossils we can reconstruct a picture of what life was like millions of years ago — how plants and animals looked, what was predator and what was prey. Free-lance writer Natalie Eason Hampton explores fossil remains on the Coastal Plain of North Carolina and explains how to collect fossil plants, seashells, bones and teeth ranging from a few thousand to 80 million years old. Sometimes these fossil finds are remains of marine creatures — sharks, whales, seals, fish and shellfish — representative of times when the ocean covered the Coastal Plain. Other fossils are bones and teeth of land-based animals — dinosaurs, sloths, mastodons, mammoths and horses — indicative of periods when sea level was lower. 10

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The fossilized bones of dinosaurs that tower in museum showrooms inspire awe in children and adults alike. But museums aren't the only safekeepers of fossils — just check the soil under your feet in North Carolina's Coastal Plain. There, you can find the fossilized remains of plants and animals that shared our state shores with dinosaurs, and even some that lived before these giants. Free-lance writer Natalie Eason Hampton explores the best fossil-finding sites in coastal North Carolina. 18

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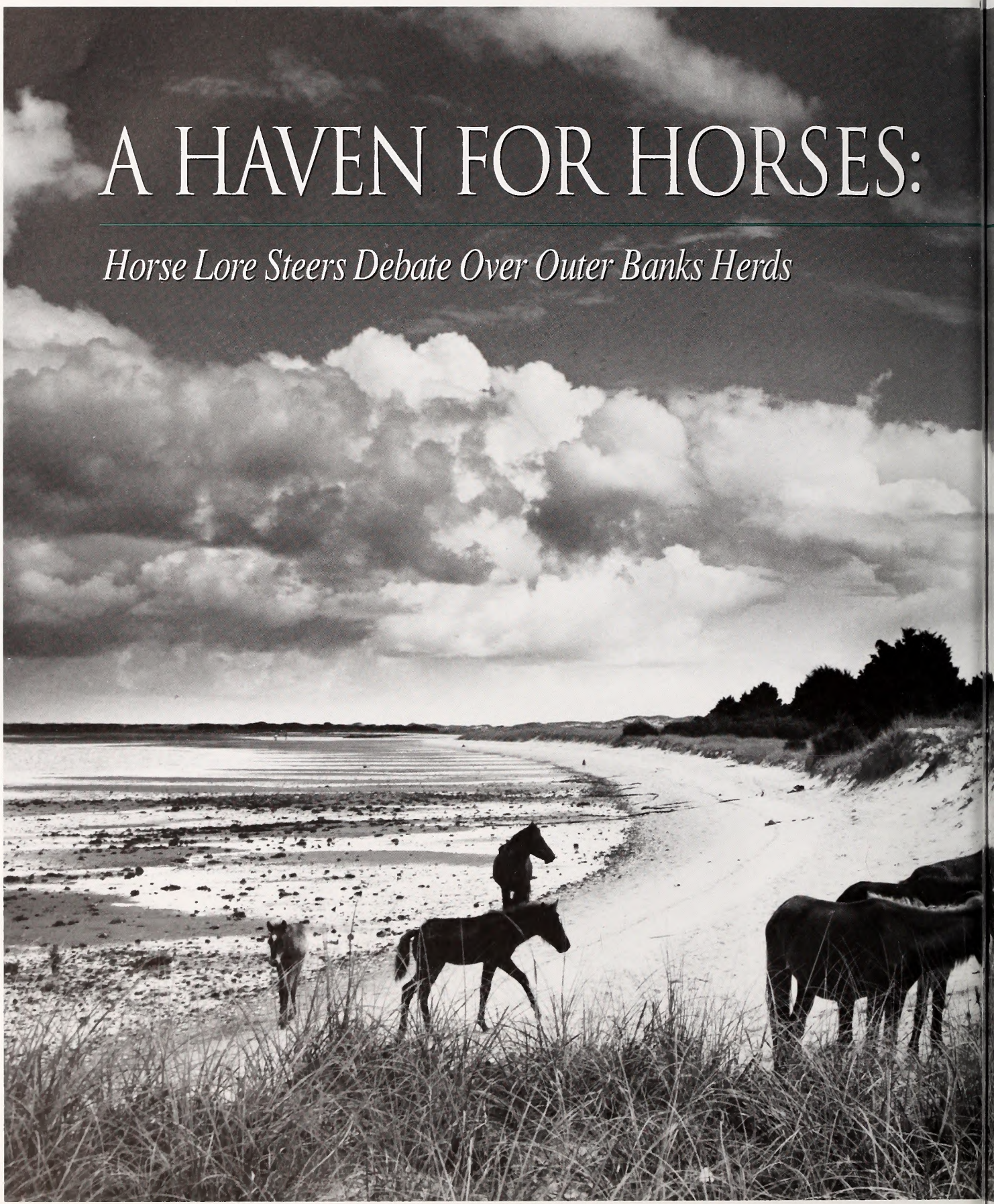

Scott D. Taylor

By Sarah Friday Peters

The phone rings in the old keeper's quarters under the early morning shadow of the Corolla Lighthouse, and Rowena Dorman bounds from her chair to answer it.

"They just called me," says Dorman, director of the Corolla Wild Horse Fund, taking her seat again. "There're three studs down in Sanderling. We've been taking those horses back [north] for the last six weeks. They won't stay because they've found green grass down there. We're going to have to do something with those boys."

Sure enough, a chestnut stallion and two walnut-brown studs feed calmly a few miles south on N.C. 12, oblivious to passing cars and a tourist snapping pictures two feet away.

THE PROBLEM BEGINS WITH THE INABILITY TO PINPOINT THE EXACT ORIGIN OF THESE MUCH-HERALDED HORSES. CLAIMS OF PURE SPANISH ANCESTRY FUEL THE FIGHT TO PROTECT THE HORSES AND TO ALLOW THEM TO RUN WILD.

For five years, Dorman and other members of the Corolla Wild Horse Fund have been trying to figure out what to do with "those boys" and the rest of the herd that roam Corolla's back yards and roadways. Until 1989, the horses ran freely through the salt marshes and dune swales of Currituck County, like some believe they had for 400 years. But development and a northward extension of N.C. 12 changed that.

The problem repeats itself many times down the 175-mile stretch of barrier islands from the Virginia line to

Continued

Gene Furr

Carrot Island. The future of the state's feral horses is in doubt, and officials face tough decisions about what should be done.

"No one ever thought this would grow into what it has become," Dorman says. "They really thought they were going to set up some control measures and that would be the end of it."

As many as 35 untamed horses run among the brush and fields of the Currituck National Wildlife Refuge north of Corolla. Twenty-one rove between the sound and sea near Corolla, and about 224 more roam Shackleford Banks and the Rachel Carson Estuarine Sanctuary in Carteret County. Only a small herd of 26 have a place to call home at Ocracoke — on about 200 penned acres managed by the Cape Hatteras National Seashore.

"People like seeing the horses," says Ken Merritt, refuge manager of the Mackay Island and Currituck national wildlife refuges. "But there are definitely some problems, and as development continues on the Outer Banks it's going to be difficult for the two to coexist."

THE HORSES' TRUE BEGINNINGS ON THE BARRIER ISLANDS ARE AS MUCH A MYSTERY AS THE LOST COLONY, BLACKBEARD'S HIDEOUTS AND THE SOURCE OF THE OUTER BANKS BROGUES.

In recent years, the "wild" horses of the Outer Banks have become one of the region's top tourist attractions. Visitors scramble through thickets and down gravel roads in Corolla to get a glimpse of the short, stocky horses unfettered by boundaries and rules. The horses' mysterious history only adds to the intrigue.

"People love horses; we all love horses," says Chuck Harris of the Cape Lookout National Seashore. But he and other wildlife managers are asking more questions about the horses' best interest, their habitat and the people who encounter them. So far, finding a balance hasn't been easy.

"Politically, it's a hot potato," Harris says. "My personal opinion is that this is, will and can be a management problem for us."

The problem begins with the inability to pinpoint the exact origin of these much-heralded horses. Claims of pure Spanish ancestry fuel the fight to protect the horses and to allow them to run wild.

The horses' true beginnings on the barrier islands are as much a mystery as the Lost Colony, Blackbeard's hideouts and the source of the Outer Banks brogues. Some residents believe the first wild ponies were left by members of the Lost Colony. Others think they swam from 16th-century shipwrecks or escaped from Spanish stock brought to the Outer Banks in the first part of that century.

The most widely accepted theory among Outer Banks residents is the idea that Spanish explorers brought the ponies from their homelands as they conquered the Americas in the 1500s.

One of those residents is Jeannetta Henning, a native of Ocracoke and wife of the late Jim Henning, a U.S. Park Service ranger who cared for the island herd.

In her booklet *Conquistadors' Legacy*, Henning, a local historian, writes that the horses originated on the Iberian Peninsula in southwestern Europe. They were bred with North African Barbs and Arabian horses for traits of intelligence, endurance, a sweet nature and "that special fire that sets them apart from all other horses."

Spanish explorers called conquistadors coveted the swift, small stallions; and as the conquerors ventured westward from Spain, they established breeding farms on islands off Central America for the horses, as well as sheep, cattle, hogs and goats, she writes.

It's possible, Henning says, that Lucas Vasquez de Ayllon of Hispaniola was the conquistador who brought the original herd to the barrier islands. He was granted land thought to have been near the Cape Fear River in the early 1500s. The colony failed, records show. His people returned to Hispaniola, but the horses may have been left on the islands, she writes.

THE MOST WIDELY ACCEPTED THEORY AMONG OUTER BANKS RESIDENTS IS THE IDEA THAT SPANISH EXPLORERS BROUGHT THE PONIES FROM THEIR HOMELANDS AS THEY CONQUERED THE AMERICAS IN THE 1500S.

Another account chronicles the voyage of Sir Richard Grenville, an Englishman who brought an expedition to America by way of the Spanish islands about 1580. His ship, the *Tyger*, ran aground in Ocracoke Inlet, loaded with food, sheep, goats, swine and horses.

From there, Henning writes, the spread of Spain's finest horses throughout the Outer Banks was only a matter of time.

These romantic stories might not ring so true to barrier island visitors and residents, except that the ponies do have a Spanish accent to them.

On a sunny day in early March, five horses — Feliz Navidad, Stormy, Lindeza, Bonita Supressa and Santiago — chew hay and lounge in the public pen just off N.C. 12 on Ocracoke.

"They're pretty hardy," says Bill Caswell, a park ranger with the Cape Hatteras National Seashore. "They probably have Spanish blood, but where that came from, we don't know."

Generally, Spanish horses like

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Park ranger Bill Caswell and one of the Ocracoke horses.

those grazing near Caswell are short, standing 14 to 15 1/2 hands, or 56 to 62 inches tall, and weigh about 1,000 pounds. Their foreheads are wide, their necks long and crested, and their chests broad. They have strong legs, a high tail and a long mane. Yet one of their most prominent features is a short back, due to five lumbar vertebrae, instead of the more common six.

For decades, the absence of the sixth backbone has been all some people needed to prove that the ponies descended from Spanish mustangs.

Many Spanish horses have five lumbar vertebrae, agrees E. Gus Cothran, an associate research professor in the Department of Veterinary Science at the University of Kentucky. But so do many other breeds.

Two years ago, Cothran, a genetics expert, attempted to decode the ancestry of the region's feral horses in a research project funded by the Eastern National Park and Monument Association.

His study on the genetic makeup of horses at Ocracoke, Corolla, Shackleford, Carrot Island and sites in Georgia and Virginia made several previously uncharted discoveries and has become a guide for genetic management of the herds.

FOR DECADES, THE ABSENCE OF THE SIXTH BACKBONE HAS BEEN ALL SOME PEOPLE NEEDED TO PROVE THAT THE PONIES DESCENDED FROM SPANISH MUSTANGS.

In one part of the study, Cothran found that the Outer Banks horses had more in common genetically with one another than with 65 domestic breeds. Evidence also suggests that few other breeds had been introduced to the Banker ponies through the years, echoing the theory that they have been isolated for a long time.

"I suspect, at least to some degree, that they all share ancestry," Cothran says from his office in Lexington, Ky. Spanish ancestry is evident, but the Banker horses are probably not straight descendants of Old World Spanish breeds, he adds. More likely, they derived from the horses bred later in the Caribbean.

Pony pennings such as this one at Shackleford Banks used to be common along Tar Heel barrier islands.

"There is evidence from genetic markers and physical appearance that they have Spanish ancestry," he says.

Research can't tell us, though, which Spanish herds they came from, when they were introduced or under what circumstances. The Banker ponies may be descendants of the conquistadors' horses or of horses imported to the Outer Banks for plowing farms in the 1920s, for instance.

"You can't make a final statement," Cothran adds. "It's just not that clear-cut."

Although Cothran did not detect similarities between the feral horses and today's Spanish breeds, he did note the horses' likeness to saddle-and-harness breeds such as saddlebreds and Morgan horses. He suggests that the Banker ponies and the saddle-and-harness breeds share a common ancestor — the Spanish jennet, a hardy Iberian horse. Similar traits are shown in the saddle-and-harness breeds through an extinct breed called the Narragansett Pacer.

Not everyone makes hay of Cothran's research.

Ernie Bowden, a Currituck County commissioner and one of the area's last cowboys, dismisses Cothran's findings, especially the part about the horses' lack of pure Spanish breeding.

"Very frankly, they have been identified as the first horses introduced by Spanish who colonized the area," Bowden says. They have a direct line, he adds, "absolutely directly."

In reality, however, the lineage is probably diluted as Cothran suggests. Many historians believe that the first settlers to the Outer Banks brought their livestock — including horses — by way of the West Indies, British Isles and Jamaica, the trade routes at the time.

None of John White's 16th-century drawings depict horses, and Ralph Lane's writings of the time are mum on the sub-

ject too. One of the first mentions of horses is by Capt. Samuel Stephens, who claimed Roanoke Island for his livestock in 1663.

Before then, more cows, sheep, horses, goats and pigs roamed the northern Outer Banks than people. Settlers used the islands to corral their stock, taking advantage of the sound and sea's natural boundaries and ample vegetation.

From the 1660s to the 1930s, the Outer Banks was cattle country. In 1934, the N.C. General Assembly outlawed open grazing, and the taste of the Wild West in the East faded. But the horses remained free and feral. Because it is believed these horses were once domesticated, we call them feral, not wild. Only one true wild breed of horse, the fierce Przewalski's horse of Mongolia, still exists.

More recently, many old-timers recall using Banker horses to pull carts of groceries across town, to haul fish nets from the sea or for farming. They remember the men of the U.S. Lifesaving Service patrolling the beach on horseback or riding the untamed horses bareback.

"We'd go out on moonlit nights and catch a horse to ride. It really didn't matter whose horse it was; nobody cared," writes Elisha Ballance of Ocracoke in *Conquistadors' Legacy*.

But most of all, Lawton Howard of Ocracoke and other residents of the Outer Banks remember the pony pennings.

On July 3, typically, locals rode north, driving 200 or 300 "wild" horses to a pen near the village for branding and selling.

"At 2 a.m., we'd go up to Hatteras Inlet," he recalls. "It'd be 1 a.m. the next day before we got back here."

Rich memories like these cause people to support the horses' unconfined existence in Currituck, Hyde and Carteret counties.

"They're really part of the history," Dorman says.

Currituck County residents have kept a watchful eye on the local herd since 1989.

"The vast majority want to see those horses preserved and protected," Bowden says.

The horses and people coexisted peacefully in the northeastern Carolina county until an extension of N.C. 12 was laid in 1984. Development boomed, and residents began complaining that the herd was chewing up their carefully

MORE RECENTLY, MANY OLD-TIMERS RECALL USING BANKER HORSES TO PULL CARTS OF GROCERIES ACROSS TOWN, TO HAUL FISH NETS FROM THE SEA OR FOR FARMING. THEY REMEMBER THE MEN OF THE U.S. LIFESAVING SERVICE PATROLLING THE BEACH ON HORSEBACK OR RIDING THE UNTAMED HORSES BAREBACK.

sown lawns. The horses found the succulent grass more tasty than their normal diet of marsh grass and sea oats.

Then the problem got worse. In 1989, cars speeding down the winding stretch killed four mares, three of which were pregnant, Dorman recounts. Since then, 14 horses have died from car accidents. The common denominators are speed and darkness, she says.

In 1989, after the first horses were killed, the Corolla Wild Horse Fund organized.

"Our goal is always to protect and preserve these mustangs," Dorman says. "That's been our number one goal from day one.

"We wanted it to be that they would be free-roaming," she says. "We've tried that for four years. It's not working. It's just a matter of time before a person's going to be hurt."

The Corolla Fund, now 1,500 members strong, prints educational leaflets by the thousands, advising tourists not to feed the horses and to keep their distance. It has erected signs along N.C. 12 and, with the county, helped establish a sanctuary that offers extra protection by making it a misdemeanor

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to harm or harass the horses. They painted fluorescent markings on the herd, then fitted them with fluorescent collars for better visibility at night. But the paint faded away, and the collars, attached with Velcro, often come off.

Still, people want to get close.

"They're concerned," Dorman says, "but they really want that closeness to the horses. And you can't really have that with a wild animal ... . Even though these horses are gentle beings, they do bite and they do kick."

People feed the herd nachos, pizza and potato chips. They offer food from their cars. They walk up and take pictures. Some try to mount them. And last July, beachgoers lured a 2-year-old colt onto a deck. The horse fell, gashed its nose and injured its eye.

THE ANSWER MAY LIE IN CONTROLLING CARRYING CAPACITY, OR POPULATION NUMBERS; SETTING BOUNDARIES SUCH AS OCRACOKE'S 200-ACRE PEN; AND UNDERSTANDING THE IMPACTS AND INTERACTIONS OF THE HORSES WITH OTHER NATURAL RESOURCES.

Last year, the Corolla Wild Horse Fund, along with Currituck County officials, realized something had to be done.

In October, members applied for a permit from the N.C. Division of Coastal Management to extend an existing fence that runs across the island north of the Corolla Lighthouse. An extension would keep the horses beyond heavy development and the highway. The plan was to corral five or six of the herd near the old Whalehead Club and push the others north, at the same time studying management options and the horses' impacts on government preserve land.

The fence, built by the fund in 1989, runs from the sea to the sound but doesn't extend into the water because of public access rights. So the horses just walk around it. An extension would make the fence about a mile long and block the horses' escape route.

In January, the state denied the permit request, saying the project did not comply with Coastal Area Management Act rules. In March, the fund was granted a variance by the state Coastal Resources Commission to build the fence as a short-term management solution. But questions still exist.

Herding the 21 Corolla horses north would push them into a 21 1/2-mile stretch of coastline owned by the N.C. Estuarine Research Reserve, the N.C. Nature Conservancy, private landowners and the Currituck National Wildlife Refuge.

"The problem exists now and we need to do something about it," says refuge manager Ken Merritt. "But it exacerbates the problem with 21 more horses."

About 35 feral horses already graze on refuge land, he explains. The U.S. Fish and Wildlife Service established the preserve in 1984 to protect migratory wildfowl, and the horses compete with that purpose. The refuge also must protect "natural" resources, and the feral horses don't fall into that definition.

Prime waterfowl areas rich in millet, smartweed and other foods growing between the dunes and the marsh are being overgrazed by horses in the refuge, Merritt says. Endangered species such as piping plovers and sea beach amaranth may receive more damage too.

For those reasons, Fish and Wildlife officials requested that the permit for the fence be denied. Another permit is necessary from the U.S. Army Corps of Engineers, Merritt notes, and his agency plans to comment again on the threat to the refuge's endangered species.

Similar problems exist on Shackleford Island, managed by the Cape Lookout National Seashore.

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"Our main goal is to perpetuate whatever natural or cultural resources are there," says Harris. In other words, if non-native species such as the horses are keeping the island from evolving in its natural state, the situation must be examined.

The National Park Service is expected this summer to begin a three-year management plan to do just that at its park property at Cape Hatteras; Cape Lookout; Cumberland Island, Ga.; and Assateague Island, Md.

The study comes just in time, says Michael Rikard, resource management specialist at Cape Lookout. Little research has been done so far on the horses' health and their impact on dune ecology, plant life and other species.

With about 200 horses running on Shackleford now, the island may be reaching its capacity, Rikard says. There is evidence already that they are affecting the natural process of salt marsh accumulation and the habitats of other native animals that use the marsh.

The horses play host, too, to a thriving tick population, he adds. And their droppings often coat the island like a thick, smelly tar.

"There are times it smells like a barnyard out there," Rikard says.

Overpopulation threatened the herd seven years ago on Carrot Island, which is managed by the Division of Coastal Management. Twenty-nine horses died during the winter of 1986, primarily from lack of food. Twenty-four healthy feral horses remain on the island today, a suitable number for a 2,600-acre estuarine reserve, officials say.

The answer may lie in controlling carrying capacity, or population numbers; setting boundaries such as Ocracoke's 200-acre pen; and understanding the impacts and interactions of the horses with other natural resources, management officials say. Further research into the genetics of the horses will also play a role in keeping the populations viable.

In the mid-1970s, for example, the National Park Service introduced an Andalusian stallion to the Ocracoke herd, which had declined from more than 300 at the turn of the century to nine in 1976. Genetic defects because of inbreeding were causing colt after colt to die.

GIVEN THE ROMANCE AND MYSTERY OF THEIR HISTORY, MANY PEOPLE WOULD LIKE TO SEE THESE HORSES CONTINUE TO ROAM THE BARRIER ISLANDS AS THEY HAVE FOR CENTURIES.

"We have a very controlled breeding program," says Caswell, the park's ranger. "The park is still looking at how many we have to have to perpetuate the breed."

Given the romance and mystery of their history, many people would like to see these horses continue to roam the barrier islands as they have for centuries. Practically, however, resource managers question the viability and effects of such random wanderings on natural habitats more rightly claimed by other creatures.

Uncovering History:

Fossils are Keys to the Past

By Natalie Eason Hampton

To grasp a fossil in your hand is to hold a key to the door of the past. When unearthed from the sediments in which they were buried, fossils help scientists reconstruct a picture of what life was like on this planet millions of years ago.

Take dinosaur fossils, for instance. Information gleaned from these fossils and surrounding sediments has allowed researchers to accurately depict these giants and their habitat. Throw in a little Madison Avenue marketing to capture the fancy of children, and there's hardly a child in America that can't say *Tyrannosaurus*.

All fossils aren't as glamorous or marketable as those of the dinosaur. But all are important to scientists looking for clues about weather patterns, ocean levels, species availability and habitat during ancient geologic periods.

When it comes to finding fossils, North Carolina's Coastal Plain offers dozens of sites where professionals and amateurs can dig for fossils millions of years old. You can dig alone or join a fossil expedition sponsored by a club or museum (see story, page 18).

All photos by Scott D. Taylor. Courtesy of Kieth Sturgeon, North Carolina Maritime Museum.

Scientifically speaking, fossils are remains, impressions or traces of animals or plants from former geologic ages. Sometimes they are the hard parts of organisms such as shells, bones and teeth that have survived millions of years. Other times, they can be impressions or molds left behind by a plant or animal long since decomposed. And yet another kind of fossil, a cast, is a mineral or sediment replica of the original organism.

Fossilization usually begins when the hard parts of an organism become embedded in mud or covered by sand from a river, lake or ocean. These hard parts may remain unchanged for millions of years, despite changes in the surrounding sediments that compress to form limestone or sandstone.

However, most fossils are altered through contact with groundwater. Percolating groundwater may cause fossils to lose their original color and luster, become stained with minerals, dissolve or be replaced with minerals such as calcite, pyrite or quartz.

Fossil tree trunks and branches may become petrified when their pores are filled with minerals, a process called permineralization. Some fossil wood found in North Carolina is so thoroughly permineralized that it can be cut with a rock saw and polished to show its cellular structure.

The ocean has advanced and receded across the Coastal Plain many times during the state's long history. Each time, new layers of soft sands and muds were laid and sometimes eroded. These soft substrates acted as a time recorder, preserving life-forms present during geologic periods known as epochs. Every epoch is chronicled by a geologically distinctive layer of sediment.

"Each bed (formation) is like a page in a book on the geologic history of the Coastal Plain," says Stan Riggs, a Sea Grant researcher and geologist at East Carolina University. "The entire Coastal Plain (of North Carolina) is made up of marine sediments stacked like a deck of cards."

Hundreds of species of fossil plants, seashells, bones and teeth ranging from a few thousand to 80 million years old can be collected from Tar Heel riverbeds, road cuts, beaches, quarries and mines. Sometimes the fossil finds are remains of marine creatures — sharks, whales,

Continued

seals, fish and shellfish — representative of times when the ocean covered the Coastal Plain. Other fossils are bones and teeth of land-based animals — dinosaurs, sloths, mastodons, mammoths and horses — indicative of periods when sea level was lower. During some epochs, the shoreline extended miles eastward of its present location.

Where limestone and phosphate mining occurs in the state, local roadways and parking lots are often paved with crushed stone and mine spoil containing ancient marine fossils.

"Eastern North Carolina is literally paved with fossils," says Vince Schneider, research associate in paleontology at the N.C. State Museum of Natural Sciences.

Mary Weeks of the Aurora Fossil Museum tells of three vacationing French geologists who were surprised to find fossils millions of years old in the state's roadway gravel.

From road maintenance crews they learned that the paving material was spoil from the Lee Creek Mine, a phosphate mining facility operated by Texasgulf Inc. just outside of Aurora. Unable to get clearance to visit the mine, the three scientists spent an afternoon picking through one of the piles of spoil that the company regularly deposits in the fossil museum's parking lot. They came away with impressive finds, Weeks says.

All fossils aren't as glamorous or marketable as those of the dinosaur. But all are important to scientists looking for clues about weather patterns, ocean levels, species availability and habitat during ancient geologic periods.

Amateur fossil hunters have made important contributions in the search for clues about prehistoric life, says Mary Watson of the N.C. Geological Survey. Geologists, who study rocks and minerals, and paleontologists, who study ancient life through fossil remains, can learn much from finds made by amateurs.

In fact, last year an amateur fossil hunter turned up a whale of a find in Halifax County. Rufus Johnson of Roanoke Rapids discovered a fossilized whale skeleton.

Although it's not unusual to find scattered fossilized whale bones in North Carolina, this discovery was significant because the bones came from the same animal, Schneider says. So far, nearly 40 percent of the whale has been recovered.

Schneider says that despite finding a large portion of the whale, its species is unknown because the head has not been located. However, he does know that the whale measured 50 to 60 feet in length and lived during the Pliocene — 4 million to 6 million years ago — when the ocean shoreline reached westward to about where Interstate 95 runs today.

To understand North Carolina's Coastal Plain formations and the significance of the fossils we find today, let's look at the state's geologic history.

• The Cretaceous period:

The oldest animal fossils of the Coastal Plain date to the Cretaceous period, roughly 98 million to 66.4 million years ago. The Cretaceous period was the final phase of the Mesozoic era, the "age of reptiles," when the existence of dinosaurs was coming to a close.

In this period, North Carolina had a subtropical to tropical climate. Hardwood trees were plentiful among lush vegetation of the coast. Large areas of swamp and woodland existed as well as open-water marine environments.

And there were dinosaurs.

Based on fossil finds of bone and teeth, paleontologists know that dinosaurs, some of which were rare, once inhabited the waters, shores and land masses of North Carolina. Imagine meeting a mosasaur, a giant seagoing

Continued

Definitions:

Invertebrates: Animals with no backbone or spine.

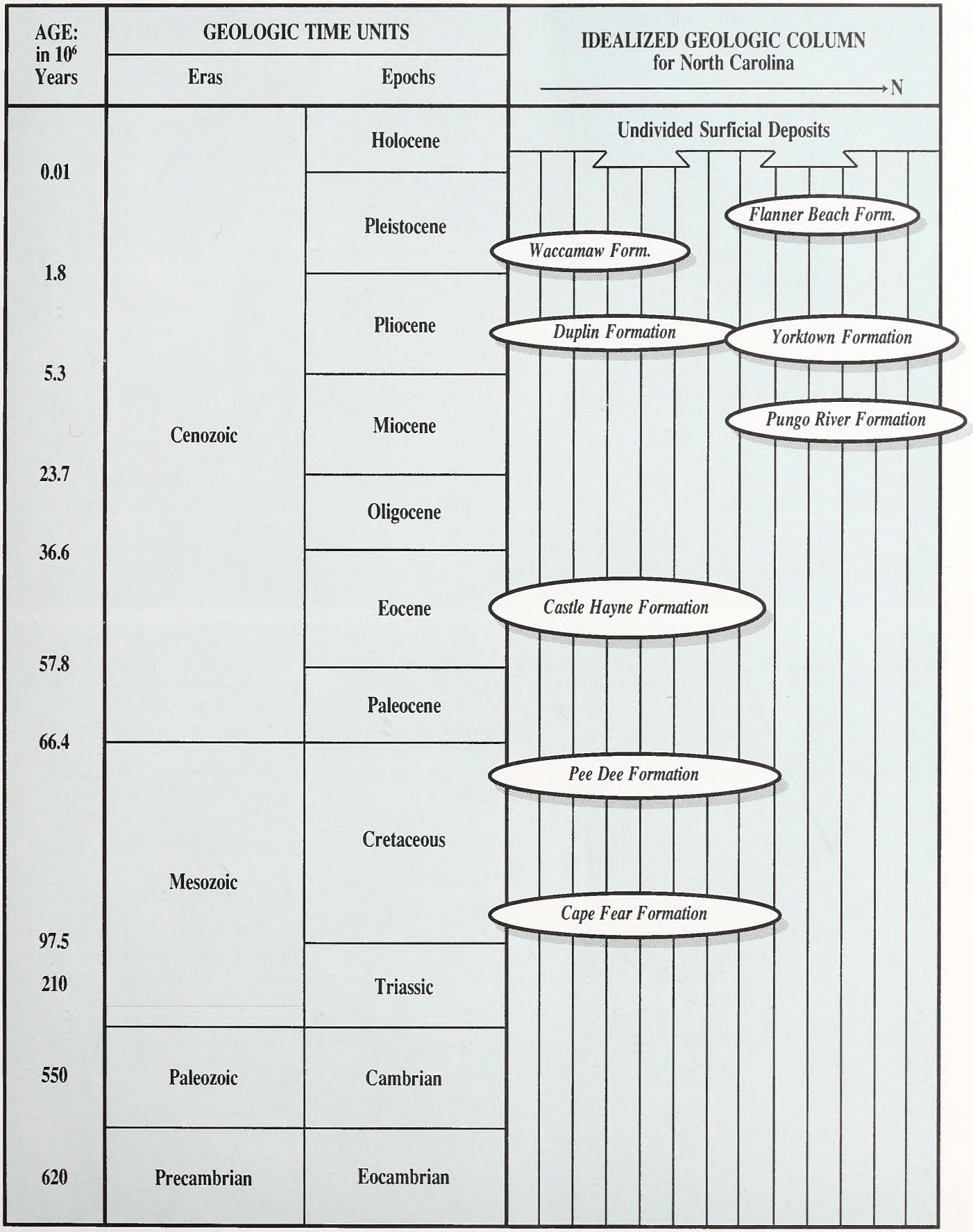
Bryozoans: Tiny organisms living in colonies, commonly called "moss animals." Their skeletal fossils consist of small boxes arranged over the surface of a structure.

Brachiopods: Known as "lamp shells," these organisms lived inside two calcium-based shells. Dating back to the Lower Cambrian (more than 500 million years ago), few species remained in the Mesozoic.

Mollusks: From a large phylum of invertebrates, mollusks have a soft, unsegmented body and usually live in a calcium-based shell.

Bivalves: Mollusks with two shells, sometimes hinged; includes oysters, clams, scallops and mussels.

Cephalopods: The most advanced mollusks, cephalopods have a large head, a well-developed brain and eyes; includes octopus, squid and pearly nautilus.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Cambrian
Eocambrian
Undivided Surficial Deposits
Flanner Beach Form.
Waccamaw Form.
Duplin Formation
Yorktown Formation
Pungo River Formation
Castle Hayne Formation
Pee Dee Formation
Cape Fear Formation

reptile closely related to snakes and lizards. Measuring up to 35 feet in length, mosasaurs had skin like snakes, five-fingered flippers and a long tail suited for ocean swimming.

Hadrosaurs, duck-billed dinosaurs measuring up to 40 feet in length, probably spent part of their life in shallow water. They were vegetarians, living off flowering plants.

Other Cretaceous dinosaurs that called North Carolina home included the *Orinthomimus*, a ostrichlike dinosaur with a toothless beak that stood 7 feet high and measured 16 feet in length; the *Dryptosaurus*, a carnivorous dinosaur measuring 33 feet that stood on powerful hind legs; and *Deinosuchus rugosus*, a 45-foot crocodile that fed on dinosaurs and other animals.

A marine reptile known as a plesiosaur swam along coastal shores during the Cretaceous period. This species had a streamlined body, short neck and paddlelike limbs.

A variety of invertebrates also dwelled along Tar Heel shores. One species that appeared throughout the Cretaceous period was the ammonite, which loosely resembled today's chambered nautilus. Other invertebrate fossils included clams, snails, tusk shells, sea urchins and sand dollars.

At the end of the Cretaceous period, many species became extinct, including the dinosaurs. Though many theories of their demise have been suggested, no one knows for certain why they died out.

Fossils from this period are found in the Cape Fear, Middendorf, Black Creek and Pee Dee formations. Outcroppings occur along riverbanks and in quarries.

When it comes to finding fossils, North Carolina's Coastal Plain offers dozens of sites where professionals and amateurs can dig for fossils millions of years old. You can dig alone or join a fossil expedition sponsored by a club or museum.

◆ The Paleocene epoch:

The climate during the Paleocene epoch, roughly 66 million to 54 million years ago, remained warm but with fewer species than the Cretaceous. The Beaufort Formation of this epoch contains invertebrate remains of oysters, lamp shells and cephalopods. Some Paleocene fossils can be found along Mosley Creek off the Neuse River, 10 miles northeast of Kinston.

◆ The Eocene epoch:

During the early Eocene, North

Carolina's climate again was tropical, and sea level ran high. Florida was submerged; the Gulf Stream flowed across Florida, Georgia and lower South Carolina; and most of North Carolina's Coastal Plain was underwater. The late Eocene was marked by global cooling. Glaciers formed at each of Earth's poles and sea level lowered.

David Campbell, a graduate student in geology at the University of North Carolina at Chapel Hill, comes from a family of geologists and fossil hunters. Specializing in fossils of the Eocene epoch, Campbell recently identified 20 new species of mollusks and a new genus of snails from the Eocene's Castle Hayne Formation laid down 54 million to 36 million years ago. His hunting grounds are limestone quarries near Castle Hayne.

These quarries contain a rich diversity of invertebrates: bryozoans, sea urchins, sponges, brachiopods, scallops and oysters. The aragonitic mineral in the shells of many invertebrate species from the Eocene have eroded, making identification of species difficult.

> Hundreds of species of fossil plants, seashells, bones and teeth ranging from a few thousand to 80 million years old can be collected from Tar Heel riverbeds, road cuts, beaches, quarries and mines.

In identifying a newfound species that has been extinct for millions of years, Campbell looks for multiple samples of fossils, trying to piece together a complete specimen like a puzzle. Taking all he knows about the internal and external characteristics of this shell, he combs literature dating back to the early 1800s for evidence of a similar find.

Strict criteria on naming zoological species require that the person making the discovery prove that the species is indeed a new find. It must be given a name that has never been used before. Naming a species is a little like doing a title search on a piece of real estate, says Joe Carter, a geologist at UNC-Chapel Hill and Campbell's adviser.

Vertebrate fossils from this epoch include remains of ancient whales, sharks, stingrays, turtles, fish and 40-foot long seagoing snakes, ancestors of the boa constrictor.

◆ Oligocene and early Miocene epochs:

This was a time of rapid global cooling and receding sea levels. Marine fossils were not as abundant. Oysters, scallops and barnacles are the fossils that mark these epochs on the geologic calendar. Most notably, oysters grew up to 12 inches long and formed bar depos-

Continued

its in shallow, brackish water.

The River Bend and Belgrade formations of Onslow, Carteret and Jones counties contain fossils of this time period, 36 million to 15 million years ago. Fossils can be found along the Trent River from New Bern to Trenton.

• Middle Miocene to Pliocene epochs:

Beneath the soils of Beaufort County, the Pungo River Formation of the Miocene epoch and the Yorktown Formation of the Pliocene hold a wealth of information about the prehistoric coast of North Carolina. Lying beneath more recent coastal formations, these two formations are like a book that might never have been opened were it not for the Lee Creek Mine.

The mine is the only land site where the Pungo River Formation can be seen without drilling a hole, and it is known worldwide for its abundant fossil finds.

Riggs is studying the Pungo River and Yorktown formations. When the Pungo River phosphate was laid down about 23 million to 15 million years ago, the ocean was extremely rich in living organisms and their remains. It contained low levels of oxygen and vast amounts of decaying organic matter.

The semitropical climate and vast supply of food provided an ideal environment for many species of marine life. Fossils from the Lee Creek Mine include a variety of invertebrate shells, whale bones, walrus tusks, seal jaws and skeletal remains of many birds and fishes.

Schneider says the ocean depth at the Aurora site was probably 500 to 1,000 feet. Fish fossils show that ocean and inshore species were very similar to those we find today. Offshore species included bonita, tuna, marlin and hake; inshore, there were sea robins, puffers and spiney burrfish.

Among the most interesting finds from the mine are teeth from *Carcharodon*, an ancestor of the great white shark. In comparison to modern great whites, which measure up to 20 feet in length, the *Carcharodon* would have marked the tape measure at 43 feet. Think about finding one of these creatures at the end of your line.

Although sharks date back nearly 300 million years, their teeth are the predominant fossil evidence left behind; their soft cartilage skeletons were rarely preserved. Shark teeth are plentiful because sharks continually shed old teeth and grow new ones. A

modern shark can shed up to 100 teeth each month.

Teeth from the *Carcharodon* can be 6 to 7 inches tall. During the summer scientific cruises off the North Carolina coast, geologist Riggs explores offshore outcroppings of these Pliocene formations on the ocean floor. Divers compete to see who can bring up the largest shark teeth, he says.

Fossil remains of whales, seals and walruses at Lee Creek Mine show teeth marks from *Carcharodon* or an occasional tooth buried in bone, evidence this great shark was abundant and hungry. It may have been the demise of this shark's food source that caused its extinction.

◆ Pleistocene epoch:

During the Pleistocene, life-forms in North Carolina began to look very much like modern species. Species dating to this period, 1.6 million to 100,000 years ago, include those of warmer climates, such as manatees, and mammoths and mastodons of cooler climates. Fossils from horses dating to the Pleistocene have been found across the eastern Coastal Plain.

> Fossilization usually begins when the hard parts of an organism become embedded in mud or covered by sand from a river, lake or ocean. These hard parts may remain unchanged for millions of years, despite changes in the surrounding sediments that compress to form limestone or sandstone.

Early Pleistocene fossils are found in the James City and Waccamaw formations. Fossils from the James City Formation, including an assortment of marine mollusks, can be collected along the Neuse River, southward from James City in Craven County. Vertebrate fossils from this epoch have been found at the Lee Creek Mine. The Waccamaw Formation contains mollusks, corals, echinoids (sea urchins), bryozoans, barnacles and shark teeth.

One interesting Pleistocene fossil find includes three sloths discovered in Wilmington by an amateur fossil collector. These fossils represent some of the oldest — 1.5 million years old — sloth remains found on the East Coast, Schneider says. More recent sloth fossils are frequently uncovered in Florida and Georgia, but these remains date back only 100,000 to 500,000 years.

Later Pleistocene fossils can be found in the Flanner Beach Formation, along the Neuse River from the Trent River to the Cherry Point Marine Base. These fossils include bivalves distinctly modern in appearance.

On a Fossil Hunt

By Natalie Eason Hampton

If you want to find out how little you know about fossils, just ask a child.

My oldest tells me that fossils are hard and lived at least 10,000 years ago. Both my children, ages 7 and 5, returned from school recently with bags of gray dirt that contained marine fossils they could readily identify.

There's something inherently fascinating to children about life-forms that existed thousands to millions of years ago. Tales of dinosaurs larger than many modern buildings seem like the stuff of mythology.

Many preschoolers and elementary school children can cite facts about dinosaurs and other ancient life-forms. And it's amazing how easily the imposing scientific names — *Triceratops, Brontosaurus, Stegosaurus* — roll off the tongues of 5- and 6-year- olds. But to see their skeletons, teeth, shells or other fossil remains is to revisit the prehistoric past never seen by man and to ignite a scientific fire within a child's mind.

Armed with a copy of *Fossil Collecting in North Carolina*, a publication of the N.C. Geological Survey, my family decided to try its luck at finding some of these hidden treasures. The book, published in 1989 and reprinted in 1993, gives detailed information on geological formations in the state and lists specific sites where fossils can be found, even by amateurs like us.

The first site we located was in Greenville, near East Carolina University. The site, number 29 in the fossil collecting guidebook, is the Green Mill creekbed, where you can find exposures of the Pliocene's Yorktown and Chowan formations.

The day we looked, rain had filled the creek, and it took a few minutes to find the designated spot where my amateur crew could unearth a fossil find. Suddenly, there it was: a wall of gray-green clay with a layer of ancient white shells glistening along the water's edge, miles from the ocean.

Because the creek was high, I decided to go alone to the water's edge to scrape a few shells. My husband kept the children on the bank. When I got down to the exposure, I was able to extract a few nearly perfect bivalves with a small gardening spade.

As we walked along Green Mill Run from the fossil site toward a nearby campus parking lot, we saw a few smaller outcroppings of shells, some of which could be easily reached by wading in shallow water when the creek was lower.

The next day, our pilgrimage took us to the Aurora Fossil Museum.

The first room of this small museum gives visitors a feel for the bottom of an open-pit phosphate mine such as the one at nearby Texasgulf Inc. The walls of the room duplicate the interior of the mine, with different geological formations exposed in layers. Also included is a replica of the enormous machines that scoop phosphate from the pit. The buckets on these machines, which look like alien invaders from one of George Lucas' "Star Wars" adventures, are the size of a two-car garage.

The next room holds a collection of fossils found in the Yorktown and Pungo River formations. Children can stand in the "mouth" of *Carcharodon*, a giant prehistoric shark whose 6- to 7-inch teeth can occasionally be found in the mine spoil.

But the main attraction lies outside the museum where the mine spoil is deposited in a vacant lot across the street. Visitors can sift through the piles at their leisure, finding shark teeth, sea urchin spines, coral and small shells.

There's something inherently fascinating to children about life-forms that existed thousands to millions of years ago. Tales of dinosaurs larger than many modern buildings seem like the stuff of mythology.

Mary Weeks, museum director, loans small digging shovels, plastic bags and a trained eye to those who want to try their luck on the spoil piles. Weeks says she can find about a hundred shark

teeth in an hour of searching the piles.

It is a fun activity for children, trying to see who can find the largest or the most shark teeth. After a few hours of digging, we came away with a handful of small shark teeth, a bag of coral and a small piece of bone.

The final day of our trip began in New Bern, a 45-minute drive from Aurora. We were looking for two sites along the Neuse River down U.S. 70 east of New Bern.

The first site, number 9 in the guidebook, is located behind Brinson Memorial School. We parked and walked through an amphitheater toward the river's edge, where we located the formation by the familiar gray-green clay protruding from the riverbank.

The guidebook indicated that this site should be visited at low tide, and we barely made it. We took an hour to pry a few clam, scallop and oyster shells from the clay. Many were brittle, but we managed to extract several nearly intact. These shells are believed to be from the Plio-Pleistocene James City Formation.

Our final site, Flanner Beach Recreation Area in the Croatan National Forest near Havelock, was not open for the season when we visited in early April. But even when open, the national forest forbids digging, and only fossils at the ground surface can be collected.

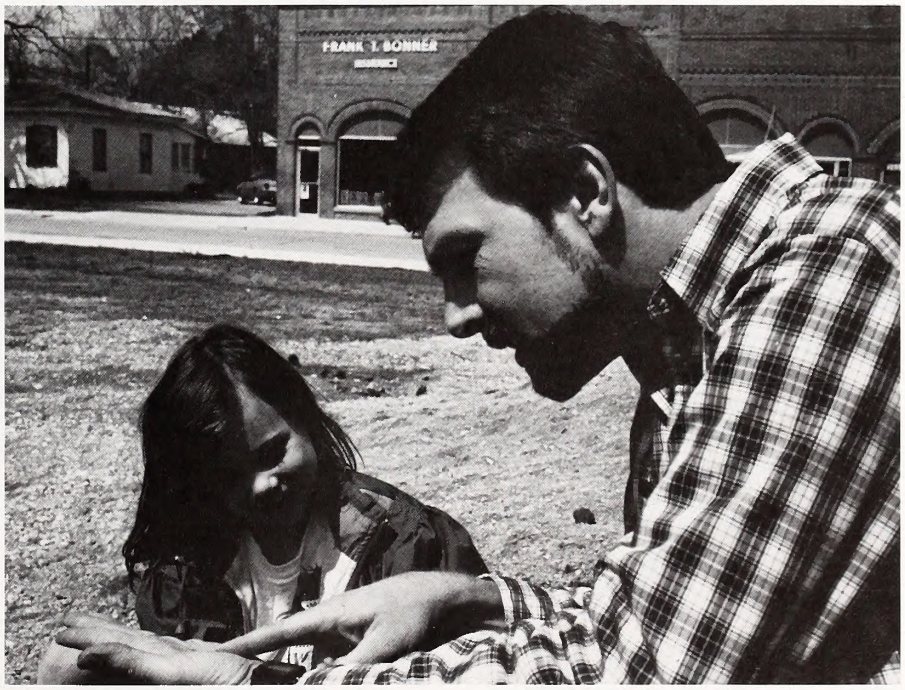
We were pleased with our finds, and we learned a few lessons from the trip. Since many sites are along riverbeds or creekbeds, a pair of wading shoes or boots is a good idea. Also be sure to pack mosquito repellent and sunscreen, and check for ticks after a day of fossil hunting.

Take along small shovels or a pick for digging. Collect large specimens in shallow cardboard boxes; bring plastic bags for smaller items. But don't be greedy; take only what you need.

When removing fossils, be careful not to destroy the habitat, and don't leave behind any trash. If you're fossil hunting on private property, seek permission from the landowner. And be careful when removing fossils from creek banks. Don't be the cause of an erosion problem that could affect water quality.

Kyle Hampton

Caroline, Allison and Natalie (left to right) sit atop a pile of mine soil at the Aurora Fossil Museum.



Natalie Eason Hampton

Kyle Hampton explains a fossil find to daughter Allison.

Fossil Collecting in North Carolina is worth its price. Joe Carter, a geologist at the University of North Carolina at Chapel Hill and one of the book's authors, identified the sites that were still viable and accessible: 2, 8, 9, 10, 12, 13, 16, 17, 18, 20, 22, 24, 25, 26, 28, 29 and 34. Based on our experience, the maps and site directions are accurate.

The book also helps with identifying your finds. Copies are available in some hobby or bookstores. Or it can be ordered by writing the N.C. Geological Survey, P.O. Box 27687, Raleigh, NC 27611. Enclose $6.50 plus tax.

Continued

Natalie Eason Hampton

Allison Hampton digs for fossils along the Neuse River.

When you get your fossils home, clean them gently. Use an old toothbrush and water. To identify fossils, use *Fossil Collecting in North Carolina*, *The Audubon Society Field Guide to North American Fossils*, *The Fossil Collector's Handbook* or any number of other such guides available at science museums or bookstores.

Or if you think you have something unusual, call the N.C. State Museum of Natural Sciences. Vince Schneider, the museum's research associate in paleontology, says he will gladly look over your discovery and help you identify it. Remember many significant fossils have been made by amateurs.

Individuals interested in fossil hunting can participate in group trips organized by the N.C. Fossil Club (P.O. Box 2777, Durham, NC 27705). This group visits many sites each year. Also, many museums, including the N.C. State Museum of Natural Sciences, the N.C. Maritime Museum and the Cape Fear Museum, sponsor fossil-collecting trips.

The Aurora Fossil Museum is located in Aurora just a few blocks off N.C. 33. For information on the museum's schedule or to arrange a group visit, write the Aurora Fossil Museum, P.O. Box 352, Aurora, NC 27806, or call 919/322-4238. The museum held its first fossil festival this year in late May. Organizers plan to repeat the event around Memorial Day each year. The festival includes tours of the Texasgulf facility, displays and entertainment.

The N.C. State Museum of Natural Sciences in Raleigh offers a fossil exhibit where visitors can watch volunteers restore fossils. The museum, in conjunction with the N.C. Fossil Club, is also planning a fossil fair on Nov. 5. There will be visiting fossil collections in addition to the museum's exhibit.

The fossil collecting guidebook lists a number of museums across the state where information about fossils can be found.

Some resources on North Carolina fossils and geology include:

Beyer, Fred. *North Carolina, The Years Before Man, A Geologic History*. Durham: Carolina Academic Press, 1991.

Carter, J.G.; P.E. Gallagher; R. Enos Valone; and T.J. Rossbach. *Fossil Collecting in North Carolina*. Raleigh: Department of Natural Resources and Community Development, Bulletin 89, 1988.

Culotta, Elizabeth. "Field Trip: A Glimpse of Oceans Past." *Earth*, September 1992, pp. 56-61.

Frankenburg, Dirk and Lundie Spence. *North Carolina Marine Education Manual, Coastal Geology*. Raleigh: N.C. Sea Grant College Program, 1989; $3.50.

North Carolina Coastal Plain: A Geologic and Environmental Perspective is a 1 3/4-hour video that uses the Coastal Plain to explain geological, ecological and environmental science concepts. Complete with script and hands-on activities, it is divided into eight segments ranging from 8 1/2 to 17 minutes. Raleigh: N.C. Sea Grant Program, 1989. UNC-SG-89-02; $30.

When removing fossils, be careful not to destroy the habitat, and don't leave behind any trash. If you're fossil hunting on private property, seek permission from the landowner. And be careful when removing fossils from creek banks. Don't be the cause of an erosion problem that could affect water quality.

Books for older children, about fossils and prehistoric life-forms, include:

Beddard, Linda J. *A Field Guide to Fossil Finds for the Young Paleontologist*. Aurora: Aurora Fossil Museum, 1991.

Lampton, Christopher. *Prehistoric Animals, A Reference First Book*. New York: Franklin Watts, 1983.

Moody, Richard. *Nature Library, Prehistoric Life*. New York: Exeter Books, 1983.

Cooking up an Estuary

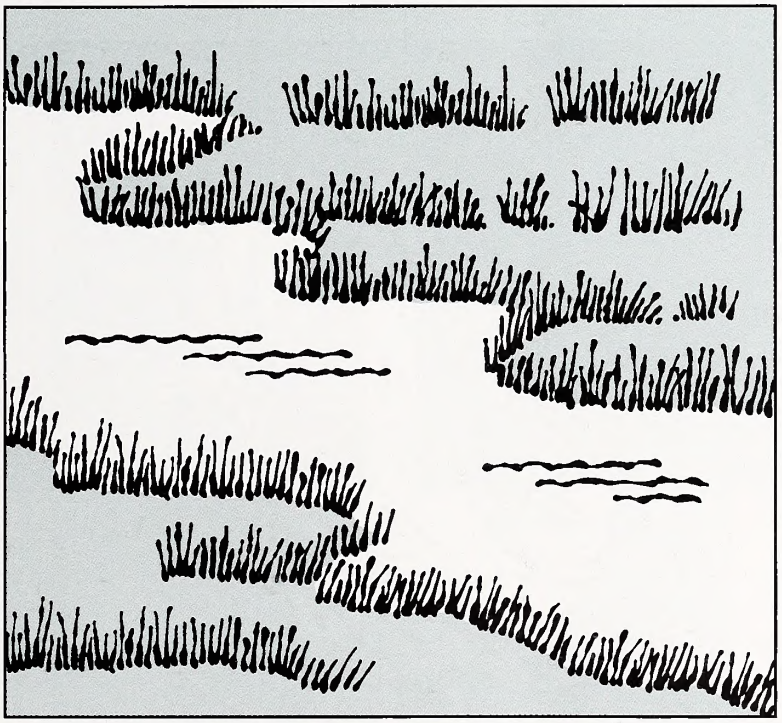
Mix several billion gallons of salt water with a like amount of fresh water. Add tons of decaying salt marsh grass, weeds and wood particles. Whisk in pounds of tiny floating plants and season with stands of marsh grass and submerged seagrass beds. Fold in a medley of critters — zooplankton, benthic worms, shrimp, oysters, clams, crabs and fish. Pour into a shallow basin rimmed with barrier islands.

What do you have?

An estuary.

For most people, the word estuary is nebulous. Is it the marsh? The sound? The bay? Creeks and river mouths?

Quite simply, it's all of the above. An estuary is where fresh water and salt water mix it up. Estuaries receive fresh water and sediment from upland rivers and tidal doses of salt water from the ocean through the inlets. Then currents, winds and tides stir the fresh and salt water into a brackish soup that teems with life.



North Carolina has been blessed with an abundance of estuaries. Some have names that are well-known — Pamlico and Albemarle sounds; others ring familiar only to the ears of fishermen and long-time natives — Rose Bay, Back Sound and South Creek.

But together, North Carolina estuaries comprise the third largest estuarine system in the United States, trailing only Louisiana and Alaska. Tar Heel residents can proudly claim 2.3 million acres of estuaries. And from this expanse of fertile water comes 90 percent of the state's commercially and recreationally important species of fish and shellfish.

Some important species, such as clams, oysters and crabs, spend their entire lives in the estuary. Others, such as shrimp, spot, croaker and menhaden, spend only their juvenile stages in the estuary's shallow fringes and fingers. These areas, considered primary nurseries by resource managers, offer juvenile fish protection from predation by larger fish and an ample supply of food to eat.

Fringing the estuary are meadows of salt marsh cordgrass and needlerush that are bathed by lunar and wind-driven tidal influxes of brackish water. Called marshes, these areas stand alongside rain forests and coral reefs as nature's most productive ecosystems.

The biomass of marshes, fertilized by nutrients from rivers, can be as high as 5 to 10 tons of organic matter per acre per year. Compare this to a wheat field that produces 1 ton per acre per year or the open ocean or desert where production is less than 0.5 ton per year.

Nutrients, washed from the land, are swept downstream via rivers and streams to the marshes. There, they are trapped by the ebb and flow of the tide. And more nutrients are added by the yearly cycle of growth and dieback of salt marsh grasses. As the grass dies and withers into the estuary, bacteria attack the plant matter, breaking the tissue into detritus, a primary food source for the estuarine food chain.

The detritus feeds tiny creatures such as zooplankton, benthic worms and juvenile fish. In turn, these creatures provide breakfast, lunch and dinner for an array of other wildlife — fish, shellfish and birds — higher up the food chain.

The tides that bathe these marshes transport the nurturing doses of marsh soup to other estuarine habitats — seagrass beds and mud and sand flats. Fields of seagrass carpet the bottom of North Carolina's estuaries, providing yet another source of food, habitat and protective cover for inhabitants.

Although sand and mud flats offer no protection, their substrates provide homes for a variety of estuarine dwellers — oysters, clams, whelks, flounder, crabs and worms.

Today, scientists understand more about the function and value of estuaries than ever before. But there is more to learn and an urgency to learn it. Development of nearby beaches and adjacent and upriver lands is affecting our estuaries.

Already, scientists are seeing changes in water quality, nutrient loads, circulation patterns and valuable habitats such as seagrass beds. The rush is on for scientists to learn more about this productive and complex ecosystem so that resource managers can have the information they need to sustain it for the future.

Kathy Hart

The Chemistry of Soft-Shell Crabs

The secret to success in the blue crab business is knowing exactly when the growing crustacean is going to shrug off its old shell in favor of a roomier one. In the vulnerable moments that the crab stands naked without its calciferous covering for protection, its wrinkled skin distends and slowly begins to harden into a new shell.

So too inflates its value as a dinnerplate delicacy.

For several hours after shedding, the body of the blue crab is entirely soft, ranking it with such savory seafood dishes as lobster, salmon and snow crab.

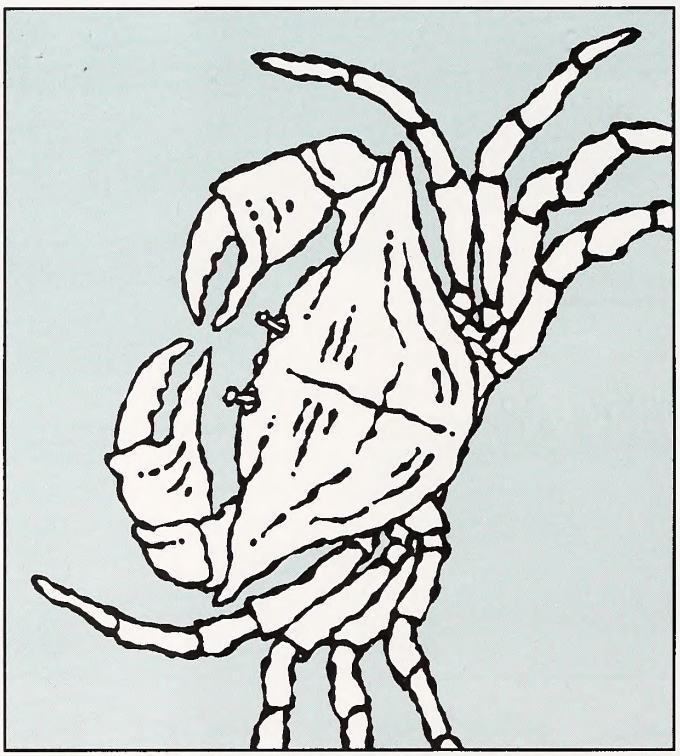
And because the crab has 10 to 15 times more edible meat in its softened state and a higher value at the market, fishermen work to catch blue crabs that are on the verge of molting. Skill at identifying these premolt crabs is critical. So is willingness to work hard when the shedding begins; shedders watch the crabs struggle from their old shells and pluck them from holding tanks before their new coverings begin to form.

But a little scientific understanding of the process will go a long way toward simplifying this tedious job of harvesting soft-shell crabs, according to Sea Grant researchers at the University of North Carolina at Wilmington Center for Marine Science Research.

Specifically, researchers Robert Roer, Richard Dillaman and Thomas Shafer want to know what changes a crab undergoes when it sheds and what controls the subsequent hardening of its new shell. They believe that glycoproteins in the crab's body at the time of shedding play a key role in the hardening process.

Glycoproteins are proteins with attached sugars that are found widely in the animal and plant kingdoms. They are involved in such diverse processes as immune system functions and formation of structural elements of bones and teeth.

The researchers believe that glycoproteins are in the cuticles that form under the crab's shell and they later determine when these uppermost layers of the cuticle will harden.



"The crabs make the outer two layers of the new shell beneath the old one when they're getting ready to molt," Roer says. "They stay soft until they molt and then expand with water to get larger; only then do they turn on calcification. The question is how the animals control that switch.

"Our research is leading us to believe that they do that by altering the glycoproteins that are there. They are using enzymes to probably clip some sugars on the glycoprotein and trigger hardening."

The two-year study is designed to tell researchers whether natural inhibitors of these enzymes can keep the crabs soft in a cost-effective manner. Roer and his associates are analyzing the proteins and glycoproteins in the shell and comparing animals before and after the new shell has begun to harden. But the scientists have to work swiftly because the transition usually occurs within two hours of molting.

If the researchers can better understand and control the glycoproteins, they can prolong the soft-shell stage by slowing the formation of a new shell. This will extend the amount of time that crabs can spend in transit to market while still remaining soft and draw out the time for harvesting them.

Moreover, a better understanding of the glycoproteins may be important in preventing bacterial contamination and death among blue crabs.

For North Carolina crabbers, the findings may mean a longer soft-shell season and big business for the multimillion-dollar industry, which garners $1 to $2 per soft-shell crab compared to pennies for crustaceans still shelled.

The spring warming of waters in the sounds and estuaries cues the blue crabs to begin shedding their winter attire for a new spring coat. After a winter of dormancy, almost all blue crabs molt this time of year during their first growth spurt of the season. They'll repeat the act 20 or more times before reaching maturity.

Watermen know the crabs' schedule for exchanging their old clothing for new. This will continue to be a necessary skill in the soft-shell industry. But the research from UNC-Wilmington may buy crabbers some time in a seasonal business where minutes and hours count.

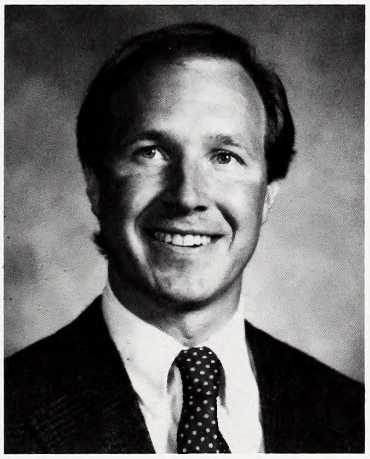
Jeannie Faris

North Carolina Examines its Coastal Management Tools

North Carolina and other coastal states are giving their management toolboxes a checkup. They want to know if the tools they use to protect and manage coastal resources are still sharp and effective.

In North Carolina, Sea Grant specialists Walter Clark and Barbara Doll are taking part in these landmark evaluations.

The process was set into motion in 1990 when Congress reauthorized the Coastal Zone Management Act (CZMA) and told states to re-examine their coastal management tools. In North Carolina, those tools are found in the Coastal Area Management Act, which was passed by the Legislature 20 years ago at the urging of the federal CZMA.



Walter Clark

Barbara Doll

Specifically, North Carolina will study four areas: wetlands, special area management, cumulative impacts of development and ocean resources planning. Through grants from the N.C. Division of Coastal Management (DCM), Clark is heading up an ocean management study for the ocean resources section, and Doll is coordinating an analysis of areas of environmental concern (AECs) for the development portion.

For years, state planning for ocean resources had fallen by the wayside in favor of land-based planning for nearshore waters, says Clark, Sea Grant's coastal law specialist. But lately, the ocean has enjoyed a surge in priority. Concern for protecting ocean resources is mounting with issues such as offshore drilling, yet there are few coordinated policies to work with.

"For so long, coastal management has ignored the wet side of its mandate," Clark says. "Coastal management was always intended to be something that would encompass the ocean as well as the land-coastal areas. But it's never done that."

The ocean resources plan that emerges from Clark's effort will mesh a resource inventory with his management study of ocean jurisdiction, public trust waters, hard minerals mining, leases on the Outer Continental Shelf for oil and gas exploration, marine pollution, fisheries, recreation and more.

Clark is working with a task force of people who use or manage ocean resources to suggest better strategies.

He will also have a hand in the conclusion of Doll's AEC study, heading a policy and management team to translate the findings into language that DCM can use for recommending new rules.

When land or water is deemed a unique natural area of statewide significance, it is granted certain protections from development and activities as an AEC. Doll has assembled scientists who will judge how well these AECs are working to protect shellfish, fish and water quality. Public hearings for the Albemarle-Pamlico Estuarine Study showed that people believe these three valuable resources are in decline in North Carolina, she says.

"Sea Grant was chosen to help with the AEC evaluation because the organization has within it all the components of this study," Doll says. "I deal with water quality. We have people who deal with the fisheries. Walter Clark deals with policy. And we're very much in touch with the leading experts doing research in these fields."

Doll started the project earlier this year by assembling teams of scientists who will define the functions of shellfish, fish and water. Oysters, for instance, are an important food source for humans, she says, but less obvious are their other functions as substrate for estuarine life-forms, food for blue crabs and filters of the water.

Each team will then draft criteria for maintaining these resources in a way that preserves their functions. For instance, oysters require good water quality. Many seagoing fish need estuarine seagrass beds in which to lay their eggs. And the quality of coastal waters can be compromised by algal growths, low levels of dissolved oxygen, nutrient loadings and sediment contamination.

The teams' criteria for keeping resources healthy will be examined by another set of experts in the study of land and water interactions. They will decide what land-based actions will meet the criteria.

When the four major studies come together, the state will have a better idea of how its management policies are keeping up with development pressures, ocean resources, wetlands and special areas such as AECs. From there, North Carolina regulators will have a better idea of how to manage the coastal resources in the future.

Jeannie Faris

Black River Upgraded

The state confirmed in April what nature-lovers and scientists have known all along — the Black River is outstanding.

By unanimous vote, the N.C. Environmental Management Commission designated the Black an "outstanding resource water," placing it in the company of similarly protected state waters such as the Nantahala River and a portion of Masonboro Sound. The protected area will also include a portion of the Black's eastern source creek, Six Runs, and part of its major tributary, the South River.

Calling the Black "the obsidian jewel of the East," commissioner and Sea Grant researcher Charles "Pete" Peterson commended state efforts to buoy its status. The state Division of Environmental Management will now implement a special management plan that prohibits new or expanded wastewater discharges and limits development and stormwater runoff near the riverbanks.

The Black's scenic beauty, excellent water quality and ancient bald cypress trees helped the river win recognition and protection; grassroots support of the plan cinched it. At a public hearing in Clinton in September, favorable comments outnumbered opposition to the plan. Of 34 letters received by the state during the month after, only two were against the ORW status.

Spence to Lead Teachers in Peru

Lundie Spence will be on foreign soil when she leads a group of U.S. teachers through a hands-on study of soil and water chemistry in Peru in July. But it's ground that the N.C. Sea Grant marine education specialist will be treading for the third consecutive summer as an instructor for the International Teachers Rain Forest Workshop.

Iquitos, Peru, is a long way from the hills of Piedmont North Carolina. But dig a little deeper and you'll find a striking similarity in the earth beneath. The weathered red clay of the Amazon Basin isn't that much different from the Piedmont clays of our state, Spence says.

"The problem of lower fertility and the need to protect topsoil from erosion and abuse exist in the rain forest, too," she says.

Spence will be in the company of tropical experts — including a Smithsonian bat expert and a medicinal plant specialist from the U.S. Department of Agriculture — who guide this unique learning experience for 80 to 100 teachers. The workshop is operated by International Expeditions of Alabama and Explorama in Iquitos.

"Ecotourists can go to these camps anytime and experience the jungle," says Spence. "This is the only week specifically designed for teacher training."

The participants live in open-air camps. They travel the Amazon by dugout canoe. And from a walkway 120 feet high in the rain forest canopy, they watch foraging flocks of parrots and tanagers.

Spence will lead a half-day workshop featuring a number of concepts in tropical soils put together by Stanley Buol and Jot Smyth, soil scientists at N.C. State University.

"We will be working with the type of soil that is available for subsistence farming, which is the same soil that supports the rich diversity of the rain forest," says Spence.

A unique scholarship will be sending a N.C. State University student along as Spence's research assistant. Jobi Bridgers is assisting in a soil profile of a 100-foot cliff above the Rio Napo that Spence and the participants began studying last summer.

"The topography of the rain forest in this area is very gentle," says Spence. "Finding this much exposure is unusual. It's like the cliff was saying, 'Come look at me. Try to figure me out.'"

The outcrop includes layers of many kinds of clays — yellow, red, blue, gray and charcoal black — and two layers of lignite, which is similar to coal.

"At the base, where it meets the river, is a layer of small shells," she says. "There's a story in these layers that tells the story of the river — its source, its geology."

Under the guidance of Paul Baker, a Duke University geologist, Bridgers has been analyzing samples from the previous cliff excavation.

"This summer we'll fill in the gaps on the profile and try to relate the profile to the soil layers that are evident in nearby subsistence farms or *fincas*," she says.

The work gives the involved teachers an opportunity to be part of a research team at the same time they are students.

"So little work has been done in this particular area," says Spence of the site. "Our results will be mainly descriptive, but they are providing a location and a base for future research interests."

Bridgers' participation is being sponsored by NCSU's College of Agriculture and Life Sciences' International Programs, NCSU International Programs/Study Abroad and International Expeditions.

For more information about the workshop, call 1-800/633-4734. Or call Spence at 919/515-2454.

Storm Drain Stenciling Joins Year of the Coast

The Year of the Coast activities committee has endorsed storm drain stenciling as a way to keep coastal waters clean of pollutants that are commonly dumped or washed off streets.

The project is poised for a midsummer start with additional funding from the N.C. Division of Coastal Management and the U.S. Fish and Wildlife Service, says stenciling organizer Barbara Doll, N.C. Sea Grant's coastal water quality specialist.

Doll plans to rally volunteers to paint storm drains and catch basins in over 60 cities that drain to sounds and estuaries. The effort will reach from the coast to the Piedmont with a stenciled educational message that reads: Keep Clean! Flows to Albemarle Sound (or Pamlico Sound or Cape Fear River).

"One goal of the Year of the Coast is to educate people about our coastal waters, and that includes how pollution generated inland affects these waters," Doll says. "This project will paint storm drains in the watersheds draining to the Albemarle and Pamlico sounds and the Cape Fear River. It will also inform people that what they do in cities such as Raleigh and Greensboro is affecting our coastal waters."

Urban runoff is a major source of nonpoint pollution, the leading cause of poor water quality and a threat to coastal waters that support fishing, shellfishing and recreation. Storm drains are a major conveyor of this pollution from streets, sidewalks and parking lots. But many people who dump trash into these drains are unaware that they flow into creeks, streams, coast-bound rivers and, in some coastal areas, directly into sounds and estuaries.

Gov. Jim Hunt declared 1994 the Year of the Coast to promote the protection and wise management of North Carolina's coastal resources. In response, the storm drain stenciling project was organized by N.C. Sea Grant, N.C. Big Sweep, Keep America Beautiful, the N.C. Coastal Federation, Stream Watch, 4-H and the N.C. Cooperative Extension Service, the U.S. Fish and Wildlife Service and the divisions of Coastal Management, Environmental Management and Water Resources within the N.C. Department of Environment, Health and Natural Resources.

As a Year of the Coast activity, organizers are recruiting volunteer groups to select the streets or neighborhoods where they will paint the messages. Meanwhile, city officials are being asked to dispense the stencils and approve painting sites chosen by volunteers. The stencils will be donated to cities on a rotating basis, and a training video and safety brochures will accompany them.

The project will continue through early fall. And once the Year of the Coast is over, Doll hopes that storm drain painting in North Carolina will continue and extend inland.

"Stenciling is a pollution prevention program that involves the community," she says. "That's what makes it so effective."

To participate or get more information, write Doll at N.C. Sea Grant, Box 8208, N.C. State University, Raleigh, NC 27695-8208, or call 919/515-5287.

Marine Resource Bibliography

Marine Education: A Bibliography of Educational Materials Available from the Nation's Sea Grant Programs has proven useful to a wide range of educators, and the demand has far exceeded supply. In its fourth printing, this bibliography is available for teachers and others interested in helping students explore and understand our oceans and Great Lakes.

The materials outlined in this bibliography are available from the Sea Grant program or institution that developed them. Entries include ordering instructions and information about materials available free or at nominal cost. N.C. Sea Grant is offering a limited number of these bibliographies free. But please include $1 to cover postage.

Marine Debris Conference

When researchers from around the world recently gathered at the Third International Marine Debris Conference in Miami to discuss possible solutions to marine debris, Sea Grant communicators Jeannie Faris and Kathy Hart listened.

In a project funded by the National Marine Fisheries Service, the communications duo attended the conference with a mission: to understand the scope of the marine debris problem worldwide and to hear the innovative solutions offered by researchers and resource managers from around the globe.

Back in North Carolina, the team is using its newfound knowledge to produce a readable booklet that summarizes the conferences findings. Such a document will be useful for maritime, tourist and waste management industries; coastal communities; regulatory agencies; and international organizations.

N.C. Big Sweep Executive Director Susan Bartholomew also attended the conference. She presented to conference attendees some of the innovative educational efforts — boat litterbags, videos, educational manuals — used by Big Sweep to educate the public about the problems of aquatic litter. Big Sweep is the nation's largest statewide waterway litter cleanup.

To learn more about the conference and findings, keep an eye on *Coastwatch.* An article will appear soon.

Nets Recycled

In another marine debris project, marine education specialist Lundie Spence is examining the potential for recycling old or torn commercial fishing nets in the Southeast.

This project, also funded by the National Marine Fisheries Service, draws on the expertise of Sea Grant fisheries specialists in North Carolina, South Carolina and Georgia. Along with Spence, these specialists will be talking with fishermen about how they currently dispose of their nets, what materials their nets are made of and whether they would be willing to bring old or torn nets to a central location for possible recycling.

Working with the recycling industry, Spence will investigate whether the nets can be recycled and if the cost of collecting the nets can be offset by recycling sales.

Net recycling has been effective on the West Coast, where fishing activities are concentrated in large ports. Fishermen can easily dispose of their nets at a central location. However, Southeast fisheries are more scattered. Fishermen use small harbors or home landings all along the coast to dock their boats. Disposal of old nets at central locations would require more time and effort by fishermen.

"Just because net recycling worked on the West Coast doesn't mean it's workable in the Southeast," Spence says. "The logistics are different, the fishermen are different, the fisheries are different and the nets are different.

"This project must look at net recycling from a Southeast point of view and determine its viability before we jump into a recycling program," she says.

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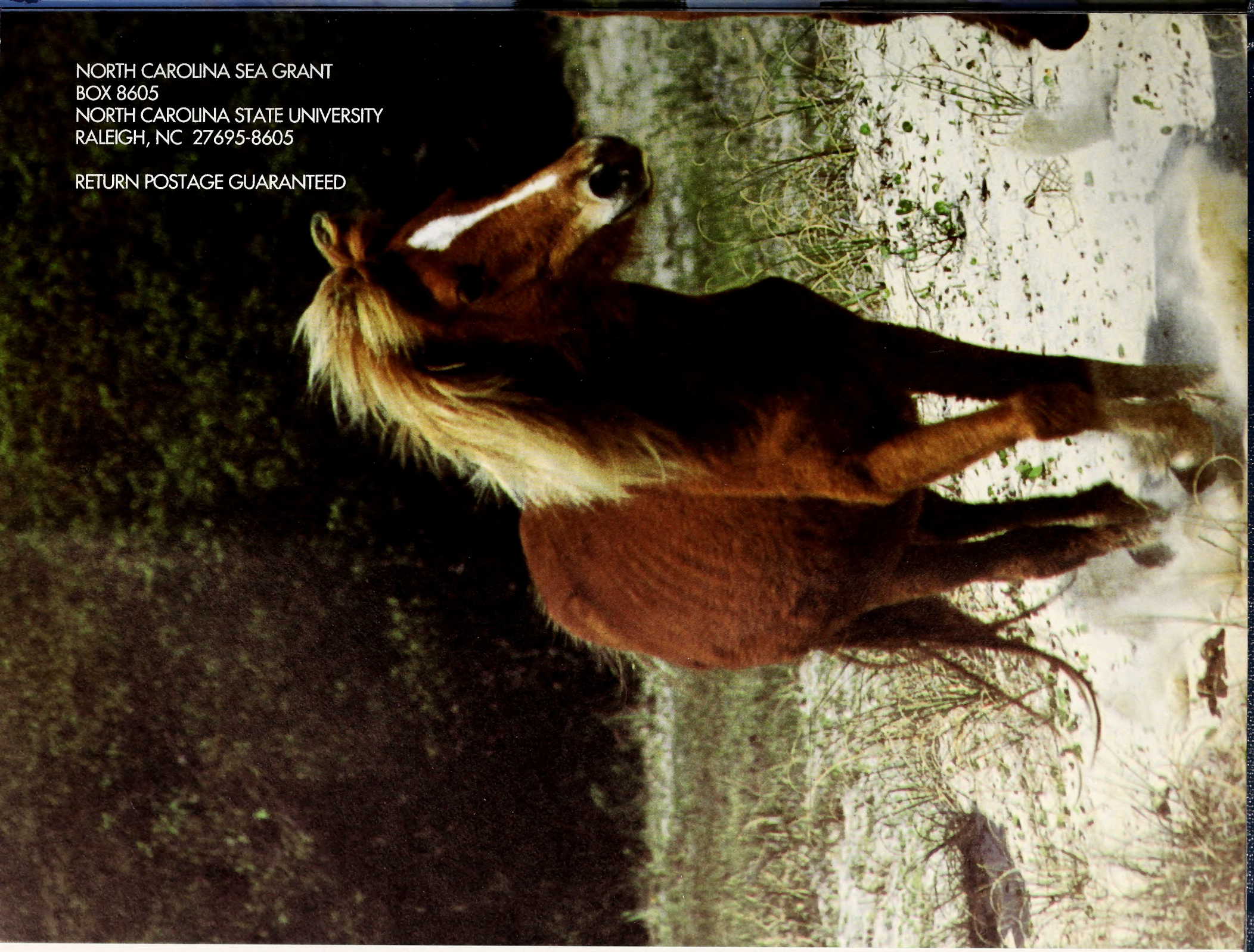

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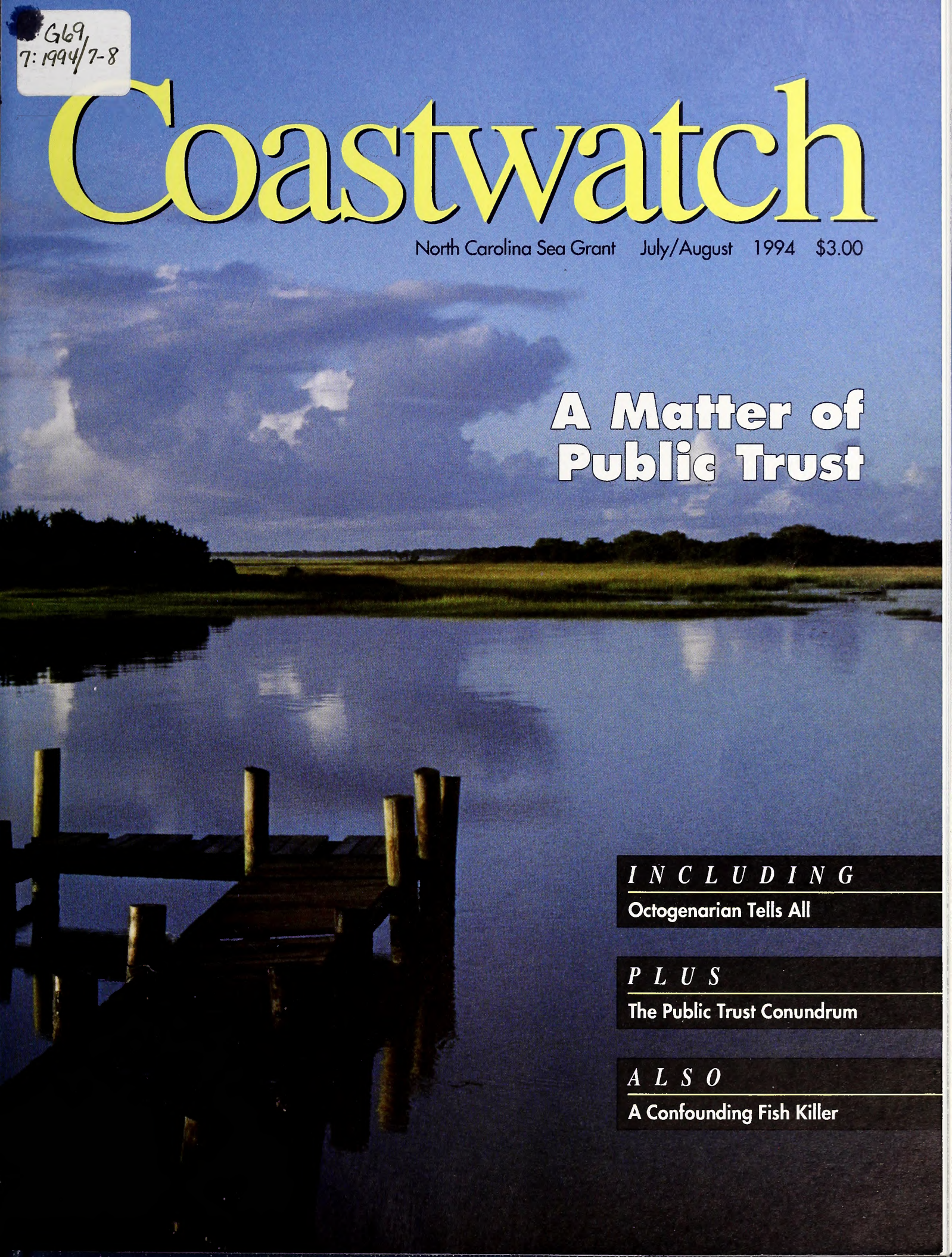

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, N.C. Sea Grant supports several research projects, a 12-member extension program and three communicators. B.J. Copeland is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

Coastwatch (ISSN 1068-784X) is published bimonthly, six times a year, for $12 by the North Carolina Sea Grant College Program, Box 8605, N.C. State University, Raleigh, NC 27695-8605. Telephone: 919/515-2454. Fax: 919/515-7095. E-mail: k_hart@ncsu.edu. Second-Class Postage paid at Raleigh, N.C.

POSTMASTER: Send address changes to *Coastwatch,* N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Front cover photo of Taylors Creek, Beaufort, by Scott D. Taylor.

Inside front cover photo of Hatteras Village by Lundie Spence.

Printed on recycled paper by Highland Press Inc. in Fayetteville, N.C.

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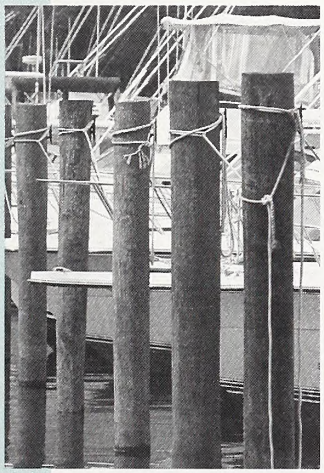

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Mutual Need unites Carolina Crab Houses and Mexican Pickers

By Katie Mosher

Just after sunrise, about 100 women — mothers, daughters, in-laws and neighbors — gather around stainless steel tables, knives in hand, swiftly pulling delicate meat out of steamed blue crabs.

The scene has been repeated in coastal North Carolina for generations.

But this is April in Chiltepec, a small town in Mexico's Tabasco State. By the first of June, these workers, along with about 1,000 other Mexican women, will be practicing the art of crab picking a world away. In fact, Mexican women now make up the vast majority of crab pickers in North Carolina.

The picking room in Chiltepec is not much different from a picking room in Oriental. Both are rural coastal communities. Chiltepec is on the Gulf of Mexico; Oriental, the Pamlico Sound.

All crab plants have one identifying aspect — the smell. This fruit of the sea has a strong aroma, which mixes with the scent of disinfectant required by health inspectors. Workers and visitors forget about the smell while there is work at hand, but the scent lingers in hair and clothes.

The buildings themselves are stark, with few windows or decorations. Crab plants in the United States tend to be cinderblock buildings painted white. But like many homes in Mexico, the plant in Chiltepec is painted bright blue.

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Just after sunrise, about 100 women — mothers, daughters, in-laws and neighbors — gather around stainless steel tables, knives in hand, swiftly pulling delicate meat out of steamed blue crabs. The scene has been repeated in coastal North Carolina for generations.

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Picking crab has traditionally been women's work in Tar Heel coastal communities such as Oriental, Belhaven and Columbia. Older pickers say men consider it "sissy work." A few men work in the crab plants, hauling fresh crabs from dock to steamer, then the cooked crabs to the picking tables and finally, carrying away the scrap shells.

Although owners cannot discriminate against male pickers, tradition at the coast has seen men gathering the catch and women processing it. But now, owners of North Carolina crab plants can find neither local men nor women to fill the open slots at the picking tables.

"I'm always looking for workers — always, always," says Patty Buck, owner of Mattamuskeet Seafood in Hyde County. "I try to hire everybody local that is possible."

When Buck opened the plant 10 years ago, she had 120 local women working in two shifts. Now she has barely two dozen local workers, and many of those only work a few days a week.

Continued

Lundie Spence

At Luther Lewis & Son in Davis, the local picking crew is down to just three women — ages 73, 75 and 83.

As local women retire, the tradition of working at the crab house is not the choice of the younger generation.

For example, Gussie Betts has made a living in seafood — shucking oysters and for the last nine years picking crab at Mattamuskeet. Yet her children have chosen a life not just outside seafood, but outside Hyde County.

One is in the Navy; another, in the Army. A third works in Greensboro, and the youngest is in college in Fayetteville.

Five years ago, Buck turned to Mexican workers to maintain production. Her first year, she brought 18 women through the federal H2B program, which provides temporary visas of up to one year for foreigners to fill jobs left vacant by U.S. workers.

This year, Buck alone has brought more than 40 Mexican women to Hyde County.

The Mexican women who come to Mattamuskeet Seafood are from Chiltepec and surrounding towns — a 12-hour bus ride from Cancun, where the workers take a plane to North Carolina.

In all, about 300 workers from that area come to work in crab plants in Fairfield, Oriental and Columbia. About 100 women spend the winter picking at the lone crab house in Chiltepec, but most only work during the North Carolina crab season.

Other Mexican workers come from a variety of locations. Those from central areas such as Durango may never have seen blue crabs before. Those from the western state of Sinaloa spend a week on a bus traveling to North Carolina.

The women have a simple explanation for why they come so far and make sacrifices such as leaving behind young children.

La necesidad. There are no jobs for them in Mexico.

Their sense of devotion to their families' futures encourages them to leave home for six months or more. This goes against the machismo Mexican culture, where the woman's place is in the home. Yet these women strike out against cultural convention and, in many cases, unsympathetic husbands.

These "guest workers" have a limited time in the states, less than one year. Also, they are limited to working for a single employer.

Bringing migrant workers is not easy, from the complicated federal applications to the upkeep on housing for the workers. "All this paperwork wipes out your winter," Buck says.

But without local workers, owners see no other choice. "There is such a decline, you can't keep operating without them," Buck says.

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All crab plants have one identifying aspect — the smell. This fruit of the sea has a strong aroma, which mixes with the scent of disinfectant required by health inspectors. Workers and visitors forget about the smell while there is work at hand, but the scent lingers in hair and clothes.

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About six years ago, a few North Carolina processors applied to the Immigration and Naturalization Service to bring guest workers. They brought about 30 women to work during the picking season that runs from May through November.

Word of the success spread quickly, and more owners ventured into the foreign labor market. To qualify, the owners had to file a request with the state Employment Security Commission showing that they had been unable to find local workers.

For example, Buck told the state she needed 60 new workers this season. The ESC sent her three. After several months, she was approved to fill up to 57 slots with Mexican workers for the season.

This spring, the state processed requests for more than 1,400 crab pickers. The actual number of workers brought in tends to be lower. Employers seek authorization for more workers, speculating on the possibility of a high-volume picking season.

Unlike the H2A program for agricultural workers, the processors are not required to provide housing. But in rural areas, rental housing is sparse, especially for dozens of women who come for the season.

Thus, Mexican workers live in housing provided by the owners close to the plant. By early May, 19 employers had registered housing. The state inspects housing to assure it meets standards set by the Occupational Health and Safety Administration.

The arrival of the Mexican workers has not always been smooth. A pair of federal lawsuits filed in 1991 showed that some employers didn't meet federal minimum wage standards, didn't pay overtime and overcharged workers for housing.

For example, one plant owner was charging $120 per woman per month for housing in mobile homes or a former hunting lodge, where the women lived three or four to a room. Under the settlement agreement, the housing allowance was limited to $8.95 per week. The workers received a refund of the $21.05 difference for each week of lodging.

After the lawsuits were settled, industry officials met with federal labor officials last year to suggest a voluntary audit of records for other plants that had not been part of the lawsuits.

As a result, dozens of companies paid thousands of dollars in back wages to workers, said Jim Whitmer of the federal Wage and Hour Division office in Raleigh.

The women are paid by the pound, from $1.65 to an occasional high of $2. If the workers do not pick fast enough to make minimum wage, the owner must make up the difference.

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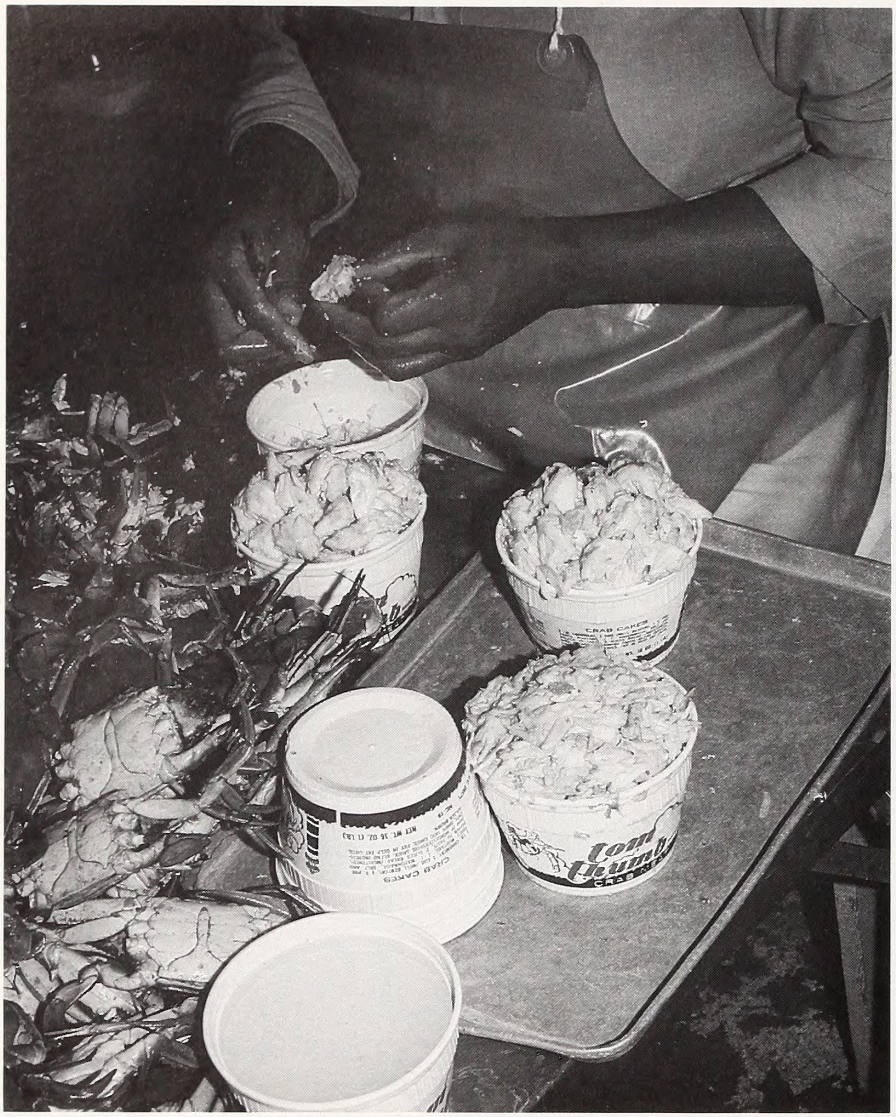
Landie Spence



Lundie Spence

Some of the older North Carolina workers have been slowed by arthritis, but they continue to pick to supplement Social Security.

Frances Davis started receiving Social Security in 1991. But as long as she has her health, she won't stop picking crabs at Thomas Seafood in North River.

"People tell me, 'Now you've got Social Security. You've been working all your life.' But I tell them, 'As long as I'm able to, I'm going to work,'" she says. "Social Security ain't stopping me. I am used to working all my life."

Younger local workers who have stayed at the plants say they like the flexibility of working at the crab house. Mothers time their work hours around their children's school schedules.

Also, workers are able to work the days they want — taking off days, weeks or seasons to meet family demands.

The pickers who have stayed on say they like working close to home, and in fact, most are working with family. They look around the room and point out cousins, sisters, in-laws and neighbors.

If these workers are happy, why has the local labor force shrunk?

Younger women often look for jobs in the growing tourism industry, which offers similar or better wages without the lingering scent of the crab house.

Some owners of the crab processing plants claim workers are not taking seasonal picking jobs, choosing to work only a few days a week because full-time income would jeopardize welfare benefits.

For whatever reason, North Carolina crab processors found themselves in desperate need of workers. Like the farmers of the state, they turned to migrant workers.

The Mexican women are eager to work. Some heard recruiters advertising on the radio for jobs here. Others were brought to North Carolina by church groups.

But much like the local workers, most Mexican women are referred through a loose network of family and friends who already have picking jobs.

The Mexican workers range in age from teens to 50s, but most are between 20 and 35. They leave behind families and, in some cases, very young children for the six-month season.

Gloria's husband got help from her sister to keep up with seven boys ages 4 to 17. Her job here has provided the growing boys with basics of food and clothes, as well as luxuries such as a new television and stereo.

Some Mexican pickers are single mothers. Most have very little formal education. All say there are no job options in their towns.

Plenty of the workers from coastal areas of Tabasco had never taken the bus to the state capital, Villahermosa, before they decided to take jobs in North Carolina. It is not the adventure but the money that draws them.

In one season in North Carolina, a good picker can gross nearly $6,000. Even after taxes, housing, food and transportation to and from North Carolina, the Mexican workers take home several thousand dollars each year — much more than they could earn at home. Without family demands, they are eager to work overtime and Saturdays to boost paychecks. Some send money orders home with every paycheck to cover the family's living expenses. Others bank the money during the season and make big purchases before leaving.

Lucina has added rooms to her modest cement home, which is off a sandy road to Playa Bruja (Witch's Beach) on the Gulf of Mexico. More important to her, she has sent one son to college, and another starts this year.

Julia was so desperate to send her oldest son to college that she took the daylong bus ride from Frontera to Chiltepec several times, begging for a chance to be added to the list of H2B workers.

Once accepted, she still had to convince her husband. Homesick upon arrival, Julia had to remind herself why she came. Her explanation, as translated to English:

"I am going definitely," she told her husband. "It doesn't matter who will cry; nobody is stopping me."

"But once I was here, I was regretting it because I was thinking of my baby," she says. "I was dreaming of him often, and there were nights I could not sleep. Can you imagine it? It is horrible; yes, it is horrible to leave your families."

At age 49, Julia was one of the oldest Mexican pickers. Trained as a seamstress, she had never picked crab before. Here she never mastered the art of picking, nor did she earn as much as her faster co-workers. She did not return for a second season.

But most of the Mexican women return season after season. The lure of a steady income may have been their primary motivation, but the women now look forward to returning each spring.

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In all, about 300 workers from that area come to work in crab plants in Fairfield, Oriental and Columbia. About 100 women spend the winter picking at the lone crab house in Chiltepec, but most only work during the North Carolina crab season.

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Unlike the local women who chat, hum or sing while working, the Mexican women often toil in silence. In contrast, music is free-flowing in their temporary homes. They celebrate Mexican holidays here and invite neighbors to join in the fun and food.

Most have not learned fluent English, but they get along. They have made friends with storekeepers and church members here, friendships that are reflected in the photos they take back to Mexico.

And in some cases, the ties are even stronger.

Guadalupe has returned to Oriental for several seasons, and now her daughter Lupita joins her.

The pair, along with other Mexican workers, found a special friend in Georgie Powell, the town's beautician and Avon lady. Georgie has even traveled to Chiltepec to visit her friends.

Her memory will last in the tiny Mexican town, for Guadalupe's older daughter, Gabby, named her baby girl after her good family friend — Georgie.

Scott D. Taylor

Scott D. Taylor

A Lesson From Miss Lue

By Katie Mosher

When it comes to crab picking, Llewellyn "Miss Lue" Lewis is a master.

Matriarch of the Luther Lewis & Son crab plant in Davis, she has taken many a novice under her wing.

"You learn by doing," says Miss Lue. At 83, she is a small, strong woman with a round face and smiling eyes.

She started picking as she neared age 50, when she was hired at Percy Davis' plant in Marshallberg. Not long after that, her son James Paul Lewis decided to open his own plant.

Having grown up on Core Sound, Miss Lue had eaten crabs her whole life. But quantity picking is different from the leisurely pace of a family dinner.

A woman from Lowlands taught her the combination of skill and speed. "Honey, I didn't learn in a day," Miss Lue says with her distinctive Down East accent.

Soon Miss Lue was a teacher herself, first coaching new workers in Davis. Later she was paid by the community college to train workers at other plants in Carteret County.

To provide a feel for the skill level required to pick crab and to demonstrate the speed needed to earn more than minimum wage, Miss Lue walks a novice through a complicated series of steps necessary for each crab.

First, gather proper equipment — an apron, hairnet and a small, sturdy knife.

Sit "way up to the table," and keep your back straight, she says. Like most of the older pickers, Miss Lue sits at the stainless steel table. Younger pickers and most of the new Mexican workers prefer to stand.

A mound of crabs — steamed to a bright orange, then cooled overnight — is heaped before her. Plastic tubs for the picked meat are in place, and a waste can sits on the floor beside her for the empty shells.

To pick meat from the body, first break off the claws. Pass them to a claw picker's pile, or slide them into a laundry basket to be taken to the claw picker.

Slide the knife into the top of the back and pull off the shell, using the knife to keep the stomach and mouth with the shell. With female crabs, the picker must also scrape off the eggs, which are olive green when steamed.

"These are the eggs," she says. "This is where the little crabs come from." Unlike caviar, the eggs are not marketable. "We'll save it for cats."

Turn the crab over and cut off the smaller legs, known as gills or fins. Miss Lue suggests putting the knife tip into the soft part of the crab and breaking the fins.

"It's like I am sewing, with a needle, you know," she says. "I twist

Continued

my hand, and I break it instead of trying to cut it." The other side is done the same way.

Right-handed people would hold the crab in their left hands. "The mouth is always toward you," Miss Lue advises.

Look for a "bridge" or ligament in the top right quadrant as the crab faces you. "I don't know if that's the right name for it; that is the name I use."

Cut through the bridge and bring the knife deep into the crab toward you. Turn that piece over and peel off the meat from a piece of cartilage not much bigger than a thumbnail.

"We call that the fan," Miss Lue says. Then carefully cut off the fan without taking meat. "You try to sliver that off."

Gently, but quickly, pick the flakes of meat by sliding the knife tip from the open end and lifting out each piece, much like taking sections of grapefruit.

"You have to go underneath, but not hit the bone." Miss Lue repeats this process on the other side by spinning the crab slightly in her left hand.

Now go for the jumbo lump, the most expensive piece of meat in the crab, by sliding the knife into the top of the right quadrant and lifting out the lump using your thumb as a guide.

A beginner will break the lump; a pro will keep it in one piece. "You have to learn that," Miss Lue says.

A full lump goes into a separate tub, for it fetches a higher price on the wholesale market. In some crab houses, pickers earn more per pound for the jumbo lump.

Once the lump is taken, the remaining meat is removed from both sides, and the other parts of the crab are discarded.

The claws offer a darker meat, which is considered sweeter and generally more flavorful than the lump or backfin. Claw meat is often used in deviled crab or crab cakes.

Claws are picked with a different, heavier knife because the claws must be broken open for the meat to be removed. A single quick strike should be enough to break the claw shell.

Loose wrists are helpful, and Miss Lue says power is a key, "like you are mad at someone."

Hold the claw, with the orange-red side up, on the brass cylinder that holds the claw in place for the cracking. Start with the side that was attached to the body and strike close to the joint.

Pull the shell away from the joint and remove the meat. Spin the claw so that the pincer is pointing to the right.

Strike closer to the pincer, and again pull the shell away from the meat.

Either pull the meat off the cartilage, or strike the moveable part of the pincer and retain the stable piece as the handle for a cocktail claw that can be easily dipped in sauce as an hors d'oeuvre.

The number of crabs that it takes for each pound of meat varies by the size and quality of the crab.

State officials estimate that 12 to 15 pounds of whole crab yield 1 pound of

Scott D Taylor

processed meat.

Personal skill is not the only factor in daily production. The women say that female crabs, whose bodies are built to protect the eggs, are harder to pick than the males. The big "jimmy" crabs are preferable to the small crabs found early and late in the season.

Machines have not yet been able to adjust for individual crabs the way these women can. As the crabs go through the molting stages, the shells can be especially delicate, crumbling easily into the meat if the picker is not careful.

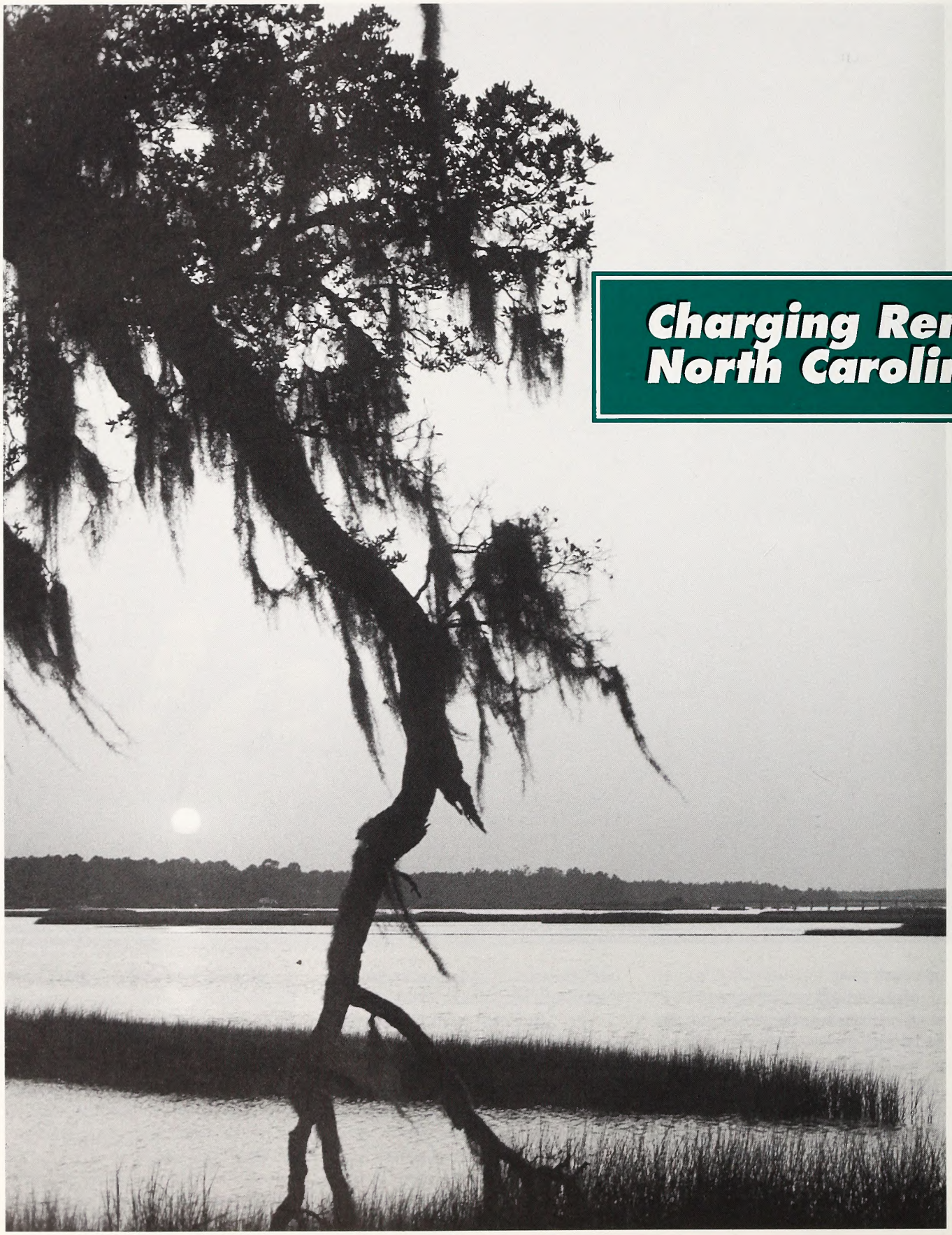
For a beginner, the picking speed tends to be hours per pound of crab meat, rather than pounds per hour.

The slow start is just too frustrating for some new workers. Miss Lue recalls one new picker a few years ago who went to get a soda on her first morning break — and never came back.

But others who may have started at only 4 or 5 pounds per day have stuck it out. Now they not only pick the 22 or so pounds needed to meet minimum wage for an eight-hour day, but many can pick 30 or more pounds.

Of the local pickers left, many are well past traditional retirement age, and their pace may be slowed by arthritis. At the Lewis plant, the remaining workers are ages 73, 75 and 83.

"It isn't hard work or old people couldn't do it," says Miss Lue, who plans to keep on picking.



Charging Rent North Carolina

Lundie Spence

on State-Owned Waters: Cracks Down on Marinas

By Jeannie Faris and John Tibbetts

To watch a shellfisherman rake the estuarine mud for clams or tong oysters from their beds, it would seem he has no expenses other than the energy and equipment needed for the task.

This is not necessarily true. Every year, tidal farmers who work private plots pay the state $5 an acre for a bottom lease or $100 to $500 per acre of water column.

A few miles away, a marina owner leases out dock slips on state-owned waters. If the shellfisherman pays for exclusive use of these waters, surely he does too.

Wrong again. Marinas pay the state nothing for this privilege.

The shellfish leases aren't costly, particularly for bottomlands, but environmentalists say the principle of charging rent to use public trust land and water is important. If aquaculturists must pay, then so should other users.

"If you're going to require leases for aquaculture, you should have them for docks and marinas," says David Farren, attorney with the Southern Environmental Law Center. "Docks and marinas have more of an environmental impact than aquaculture."

The North Carolina court system recently gave teeth to Farren's argument, at least for marinas. A major court-ordered overhaul is about to change the way trust areas are managed for these exclusive, for-profit uses.

North Carolina is poised to become the fourth state in the Southeast — joining Mississippi, Florida and Virginia — to charge marinas for the water they occupy. About half of the nation's coastal states have similar policies.

Lease programs for aquaculturists and other private users of public trust property are in place in 27 states, including all coastal states, says P.A. Wojciechowski, director of North Carolina's Submerged Lands Program. These users generally pay one-time fees, yearly rents, percentages of gross receipts or some combination.

North Carolina Marinas

North Carolina has more public trust waters than most states, and competing demands to use them are rising like high tide on a full moon. Against this backdrop, the state is proposing a 10-cent fee per square foot on marinas that occupy this public property.

The fee, however, is a temporary fix to satisfy recent court rulings and will probably be revisited by the Legislature, says Joe Henderson, deputy director of the State Property Office.

He explains how the issue has unfolded in North Carolina.

The Department of Administration — charged with managing the state's submerged lands — has always exempted marinas and docks from a state law requiring for-profit, exclusive users of public trust areas to pay fair market value. The rationale was that they had riparian rights to the water as owners of waterfront property. As such, marinas weren't expected to apply for easements or pay the associated fees to use these waters. An easement is a land transfer recognizing, in these cases, a right to build docks on state-owned waters. It can be revoked.

The courts, however, called the state's hand on this policy last year.

The proposed fees are a reply to two court cases — including a Sept. 7, 1993, ruling by the N.C. Court of Appeals — that found North Carolina was not following the letter of its own law. One case involved a proposed Black Rock marina on the Chowan River; the other, a major dredge-and-fill permit to build a marina on Smith Creek in Oriental.

"The court case and the administrative law judge said that the riparian right is an individual right," Henderson says. "So if I own land that fronts on the river or sound, then I have the right of access to deep water. It doesn't mean that I have the right to build a marina or boat yard or anything else out there to provide access to other people."

In other words, riparian rights aren't good enough for marinas. The loophole must be closed to these for-profit users, who will be required to get easements and pay rent.

Two newly proposed marinas have become the litmus tests for both. One is an 80-slip marina proposed for Chocowinity Bay in Beaufort County that could eventually be expanded to 250 slips. The other is a 12-slip marina proposed by a property owners association in Wrightsville Beach.

The city of Wilmington is also seeking an easement to build a public dock on the Cape Fear River, but it would be exempted from charges as a governmental entity.

Traditionally, environmentalists have trumpeted public trust fees as essential to state stewardship of its natural resources. But Farren has taken issue with the price offered by the state. It's too low, he says.

North Carolina is poised to become the fourth state in the Southeast — joining Mississippi, Florida and Virginia — to charge marinas for the water they occupy.

"An easement at 10 cents a square foot per year simply does not reflect fair market value for a marina where slips can be rented for a multiple of that figure per month," he says.

State property officials arrived at the fee after surveying similar charges by Texas, Florida and Ohio. Florida charges developers 10 cents a square foot each year. Texas charges 20 cents for every square foot of water covered by docks

Continued

plus $3 for every linear foot of boat slips.

Farren says that unlike North Carolina, most other states don't require a fair market compensation for use of public waters.

The fee will be revisited along with other questions, Henderson says, such as whether new and existing marinas should pay and how the proceeds should be spent.

"It's an interim proposal because we realize the sensitivity of the whole issue," he says. "It's something the Legislature will probably want to study in greater detail and at greater length."

Private Property Rights vs. Public Trust Rights

When marina operators pay compensation, environmentalists say, states benefit in several ways.

First, the number of marinas is better controlled. Coastal ecosystems have deteriorated as more people have moved to the shore. Meanwhile, regulatory agencies have continued to permit marinas and other docks. Easements will better account for state waters that are covered by marinas.

North Carolina has more public trust waters than most states, and competing demands to use them are rising like high tide on a full moon.

Also, the fees might pay for mitigation programs to repair damage from development, increase public access, enhance habitat and acquire wetlands. But as the law is written now, the money raised by private uses of submerged lands goes to the state literary fund, which helps to build schools and pay teachers.

"At least a portion of profits from the use of public land should be returned to the public," Farren says.

On the other hand, there are drawbacks to charging compensation, says C.C. Harness, a former S.C. Coastal Council attorney who labored with the same issues south of the border. "When people start to pay for or lease public bottomlands, they start to believe that they own these areas, and they don't."

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In North Carolina, the Department of Environment, Health and Natural Resources is guarding against these fees being seen as a substitute for careful review of proposed marinas under the statutes it administers, says Richard Whisnant, DEHNR general counsel.

"No matter how much someone is willing to pay, some projects may not meet the development standards and should not be permitted in the first place," he says.

Marina fees have recently gained support from some influential North Carolinians. *The News & Observer* in Raleigh noted in a June 1993 editorial, "If a (boat) slip can sell for $30,000, paying the state $3,000 for the right to build it and several hundred dollars a year thereafter for its use should pose no problem for either builder or buyer."

Others see financial and environmental restrictions on new marinas as an obstruction of economic growth.

When a marina can be an economic asset to a community, it should not be discouraged by government fees, argues Monroe Bell, developer of the proposed Black Rock marina.

"In economically depressed rural areas of eastern North Carolina, a marina would provide jobs in construction, maintenance and administration of the facility," Bell says. "A marina would provide access for the boating public, increase the tax base and infuse the local economy with dollars. Today, a demand exists for boating facilities, and government should encourage the placement of marinas until this demand is satisfied."

The same story could be heard in just about any marina you pull into.

At Wrightsville Beach, Atlantic Marine owner Gene Floyd says a charge for bottomlands would be a drain on North Carolina marinas. His marina keeps 500 boats in dry storage with a 350-foot waterfront for loading and mooring.

"We have a small area of the water that we cover, but for the state to come and charge us for that bottomland, it would work a hardship on us," Floyd says. "With the restrictions on marina operators now, it's almost impossible to put in a new marina."

Add to that the prospect of marinas passing the higher price of access onto

boaters, and these charges become another burden on people trying to enjoy public trust areas, says Don Kirkman, director of the Carteret County Economic Development Council.

"Marinas, contrary to popular belief, are not cash cows," he says. "They are expensive to build and maintain, and they are not in many instances significantly profitable. They change hands so much because people in the business are not making a go of it. The expense will be borne by the users. It would be naive to think that somehow the owner of the business is going to absorb all of those costs."

Private docks, unlike marinas, are not required to pay compensation in most states, including North Carolina. This is partly because they've traditionally been considered not-for-profit uses of public bottomlands.

North Carolina has no plans to make the regulatory leap from marinas to dock developments, Henderson says, although some environmentalists argue that perhaps it should since docks are often financial investments.

Farren is championing the fair market fee for marinas and similar exclusive, commercial users; other not-for-profit private users could pay across-the-board charges. This plan would slow the spread of private docks and encourage joint uses of public facilities, he says.

"This is consistent with the state as trustee to protect public trust assets and seek a return to the trust," Farren says.

A case raising these points is already in the South Carolina court system.

In the case of *Kiawah Resort Associates v. Sierra Club*, the South Carolina Sierra Club argues that KRA should not be allowed to build docks on Kiawah Island public bottomlands because the developer stands to reap substantial profits from their construction.

"If you are truly interested in riparian access, and you want to build one dock, I think it's all right," says Sierra Club attorney James Chandler. "But if you want to exploit trust areas for profit, that is fundamentally different."

Yet property owners note that anyone who builds a dock will probably make money from it. A dock will almost always enhance the value of a waterfront lot. Thus, if developers with multiple docks could not benefit financially from appreciation of their property, then individual landowners couldn't either, says KRA's attorney Trenholm Walker.

Property advocates note that the profit motive cannot be eliminated from public areas. People fish and harvest shellfish, for example, in public waters and sell their catch for profit.

Traditionally, environmentalists have trumpeted public trust fees as essential to state stewardship of its natural resources.

"I have a concern about the impact on commercial fishing," Kirkman says. "The two (North Carolina) court cases deal with marinas, but if one takes the argument that the state must be compensated for the fair market value for usurpation of public trust waters for private use, the same argument will apply to anyone who uses public trust waters.

"It could have a significant impact on the fees paid by shellfishermen, by recreational fishing piers, on commercial gear such as crab pots, nets and the extraction of fish."

Only for-profit, exclusive users must apply for easements and pay fees, as the law is written now. Fishermen, for instance, won't be charged fair market value on public trust areas because they don't use any stretch of water exclusively, Farren says. But that's not to say that fees on other private uses won't eventually be explored, he adds.

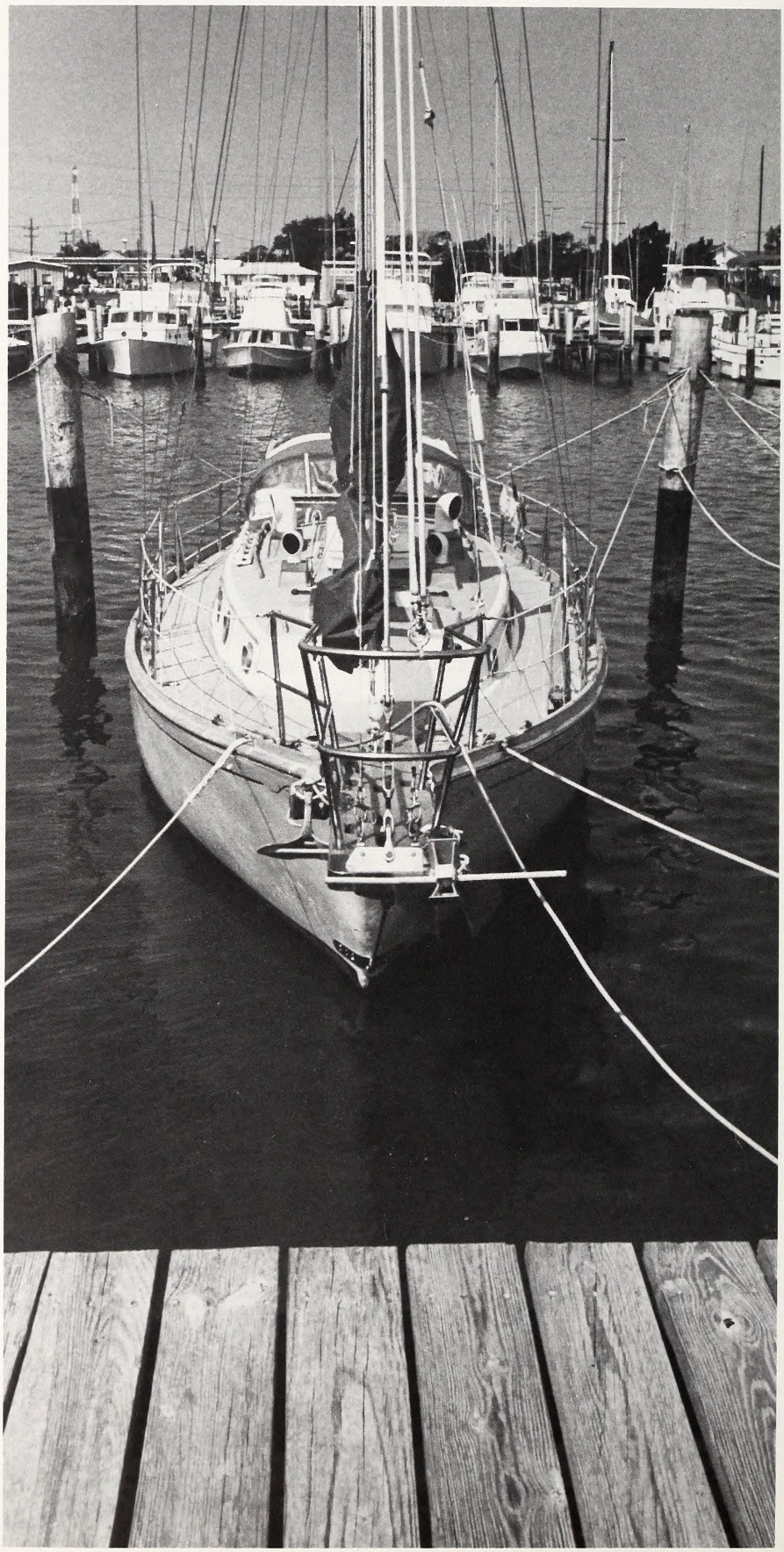
As North Carolina wrangles with these issues and the legislators enter the fray, environmentalists and property advocates can agree on one thing. Charging one group for private uses of public waters raises questions about how others can use them, and where state decisions are made on this slippery slope of stewardship and accountability will have far-reaching consequences for how we treat our public trust properties in the future.

Tibbetts is a staff writer for Coastal Heritage, *a publication of the South Carolina Sea Grant College Consortium. He explored public trust issues in the newsletter's Spring 1994 issue.*

Scott D. Taylor

A Balancing Act: Public Waters and Private Use

By Jeannie Faris and John Tibbetts



Neil Caudle

What do duck blinds in the Pamlico Sound have in common with shellfish leases in Core Sound, crab pots in Bogue Sound and marinas in the Chowan River?

They are all private uses of the state's public trust waters.

Most of us at one time or another will use public land or water to hunt, fish, boat or swim. This is a constitutionally guaranteed right, although we must follow certain rules to enjoy it. The state is entrusted with the job of enforcing these rules and protecting the resources and their public uses.

As the trustee of public water and land, the state also has the power to grant private uses of these resources. Marinas and docks are the most common exclusive uses. Less obvious are pound nets, crab pots and gill nets set by fishermen.

In times past, many private uses went unnoticed because of North Carolina's vast water acreage and its small population. But times are changing, and more people are competing for the finite coastal waters and resources. As a consequence, the state is searching for a balance between protecting the natural resources and allowing appropriate private uses in public waters.

The state's role as steward of these trust areas — land and water owned by all — is best understood by thinking of the waters as park lands, says Walter Clark, N.C. Sea Grant's coastal law specialist. Exclusive, private uses of these areas are regulated and weighed against the loss of public access.

"Compare marinas to private concessions in state parks," Clark says. "They provide a public benefit, yet arguably, their owners should pay something for making a profit from state property. Of course, whatever they pay should be fair and not so burdensome as to drive marinas out of state waters."

In North Carolina, marinas have been the legal testing grounds for the state's management of private, for-profit uses of public trust areas. The ripples of court decisions might eventually rock developers who build docks to enhance land value and even single homeowners who want to enjoy a dockside view or moor their boats.

At present, however, there are no plans to extend the newly interpreted rules beyond exclusive, commercial users of public areas, says Joe Henderson, deputy director of the State Property Office.

The debate has centered on marinas' rights to profit from the free use of public resources.

Environmentalists argue that marinas have no such rights, particularly when they might harm the nearby ecology. Developers, however, argue they have a "riparian" right to build docks and marinas on water adjacent to their property.

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Most of us at one time or another will use public land or water to hunt, fish, boat or swim. This is a constitutionally guaranteed right, although we must follow certain rules to enjoy it. The state is entrusted with the job of enforcing these rules and protecting the resources and their public uses.

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The court rulings have fallen on the environmentalists' side. Courts have ruled that marinas — defined as facilities for more than 10 boats by the Division of Coastal Management — must apply for easements, which are a management tool granting someone specific rights to use land owned by the state.

The state had not required easements or the associated fees before the rulings.

Historically, riparian rights applied only to a small portion of water, but the ability to build marinas and multiple docks has pushed these limits and launched the debate over uses of public trust waters. This pattern has been driven by demand for access to the water. From 1980 to 1990, North Carolina permits were issued for 144 marinas and 655 other multiple-boat facilities. Over 14,000 new slips were authorized by these permits.

The Public Trust Doctrine

The public trust doctrine gives states control over waters in navigable rivers, streams, lakes, and in the ocean from three miles offshore to the average high-tide line.

It also lets the state shape policy for private uses of these waters, such as where marinas are built, where docks are erected and where shellfish are harvested.

"The public trust doctrine is designed to be flexible," Clark says. "North Carolina courts have interpreted the doctrine recognizing that new rights may be added if the needs of society so dictate."

In recent years, a new pattern of public trust laws has emerged from U.S. courts. For generations, the courts had narrowly interpreted the doctrine to keep fishing grounds and shipping lanes free from private control or interference. Its original intent was to limit obstructions to trade and protect commerce.

But this interpretation has broadened to embrace environmental and recreational concerns as well. Accordingly, as the nation's population has edged toward the coast, some government controls on waterfront development have increased under the auspices of public trust.

Still, there is no universal law on the subject of public trust doctrine. Each state applies the doctrine according to its own views of justice and policy.

Private Uses

In North Carolina, property owners have generally been allowed to build docks in trust areas if they don't unfairly interfere with public uses. Marinas, on the other hand, have had to satisfy a list of environmental standards before crossing trust areas with their docks and boat slips.

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Now, the courts have added two new steps to the process. Marinas must secure easements to the state land and water they occupy. As a consequence, they are subject to fees on those uses.

Henderson says the State Property Office will require easements for any proposal that would have more than a minor impact on public trust waters. That means all marinas, he says.

Traditionally, a marina was automatically cleared for construction by the state Department of Administration if it passed muster under the Coastal Area Management Act (CAMA). The Department of Administration manages all submerged lands owned by the state, but it cannot sell them.

CAMA is administered by the Division of Coastal Management, a division of the Department of Environment, Health and Natural Resources (DEHNR). Coastal Management measures the marina proposals against standards spelled out in public trust and estuarine waters "areas of environmental concern."

These standards require, for instance, that developers exhaust options — such as upland basins or dry storage areas — to avoid building in public trust waters. Projects should not obstruct navigation or cause environmental degradation or habitat loss. Nor should nonwater-dependent structures, such as restaurants or hotels, be allowed. And docks should be limited to a certain size.

Easements will introduce a new level of review at the State Property Office — an office within the Department of Administration — once a marina has gotten regulatory clearance from the Division of Coastal Management.

First, the office must decide if granting an easement would be in the state's best interest. The grounds for this decision are still unclear, Henderson says.

Next, most marinas will make a review pass before the N.C. Joint Legislative Commission on Governmental Operations, a high-powered commission seated by the Senate pro tempore, the speaker of the House and other lawmakers. Easement applications for land worth less than $25,000 can skip this step.

"This interjects a whole new level of review and scrutiny in the easement process by the legislators," Henderson says. "And how they will look at (proposed projects), I don't know."

And finally, the applicant must fall into line with other proposed state land transfers to be signed off by the governor and Council of State.

The entire process will probably take a couple months longer that it does now, Henderson says.

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As the trustee of public water and land, the state also has the power to grant private uses of these resources. Marinas and docks are the most common exclusive uses. Less obvious are pound nets, crab pots and gill nets set by fishermen.

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Lundie Spence

Public Uses

Public uses of trust areas — more so than private uses — are regulated by a virtual army of local governments and state agencies. But missing from their ranks are any commanders-in-chief. Agencies and commissions control overlapping uses with little interaction.

Recreational boaters, for instance, must register their vessels with the Wildlife Resources Commission and abide by the rules of the water, providing lifejackets and honoring no-wake zones. The wildlife division polices inland boaters for safety violations, while the U.S. Coast Guard patrols the coastal area. DEHNR's Division of Marine Fisheries regulates the catch of commercial and recreational fishermen and moderates squabbles. It has also made rules to keep stopnet fishermen at a distance from commercial piers. Surfers, too, are prevented from hanging-ten too close to piers by town and city ordinances.

As a result of the regulatory anarchy, conflict resolution is difficult when jet skis run afoul of swimmers or shoreside property owners, or when boaters tangle with fishermen's nets.

Space allocation — another word for water-use zoning — is one solution for refereeing the clashes on North Carolina's waters, Clark says. Again, like private uses, a wide-angle look at how waters are managed would reduce conflicts.

The problem, however, is that extending the concept of land-use zoning into the water would require funding that isn't available now, Clark says.

N.C. Sea Grant is planning a conference on public trust issues. For information, contact Walter Clark at Box 8605, N.C. State University, Raleigh, NC 27695 or call 919/515-2454. To learn more about the public trust doctrine, ask for the Spring/Summer 1994 issue of Legal Tides.

KILLER DINOFLAGELLATE

Learning About a Toxic Dinoflagellate and its Impact on Fish and Shellfish

By Kathy Hart

Recently, N.C. Sea Grant researchers discovered a fish killer — a microscopic animal that paralyzes fish with toxins and sucks away their flesh.

JoAnn Burkholder, an aquatic botanist at N.C. State University, says people shake their heads in disbelief as she describes the dinoflagellate that appropriately is named *Pfiesteria piscimortuis*. It species name means fish killer.

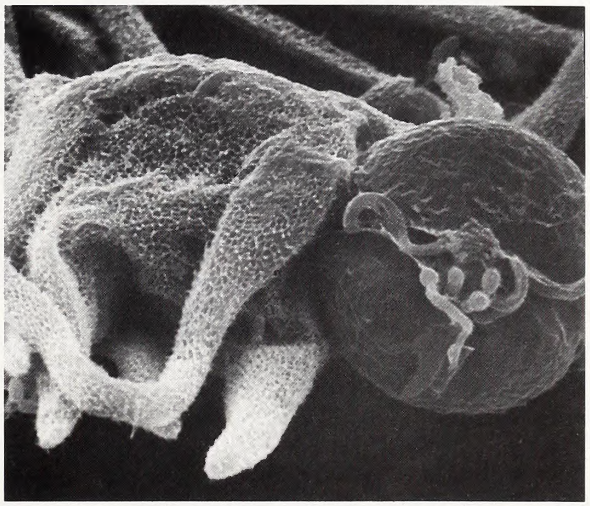
Sea Grant fish pathologists Ed Noga and Steve Smith of the NCSU College of Veterinary Medicine discovered the dinoflagellate when about 300 fish in a brackish-water aquarium in their lab went belly-up with no apparent cause. The water had been taken from the Pamlico River, but Noga could find no pathogens or bacteria. He did, however, find the water swarming with microscopic dinoflagellates — single-celled animal-like organisms.

Dinoflagellates aren't unusual. Along with diatoms and other forms of microalgae, they compose the bottom of the aquatic food chain and are among the most primitive forms of life on Earth. But some dinoflagellate species, such as the red tides, are toxic.

Noga realized this dinoflagellate was different, however. This dinoflagellate attacked fish. Its toxicity wasn't a defense mechanism designed to keep fish from consuming it. On the contrary, this dinoflagellate was a predator in search of prey.

To determine its identity, Noga sent samples of the dinoflagellate-infested water to aquatic botanists along the East Coast. Among them was Burkholder, an NCSU colleague. At first, she was unbelieving of Noga's description. But as she and her students began to study the dinoflagellate, she made some startling discoveries about this horrific killer.

Light brown in color, this microscopic dinoflagellate is so small that millions would fit on the head of a pin. It's an animal, Burkholder says. But sometimes it masquerades as a plant after eating algae, one of its food sources.



Pfiesteria piscimortuis

The dinoflagellate digests all of the alga except the chloroplast, which is the part that draws energy from the sun via a process called photosynthesis. The chloroplast continues to photosynthesize inside the dinoflagellate cell, falsely giving the impression that the dinoflagellate itself is performing this plant-related process.

Unlike its close relatives, the red tide dinoflagellates, *P. piscimortuis* gives no evidence of its presence. There is no discoloration of the water or other obvious clue that it is lurking in the water column or hiding in the sediments.

It's even hard for scientists such as Burkholder to detect because it transforms into at least 15 life stages. It ranges from a dormant cyst in the sediment to a toxin-emitting single cell with threadlike extensions called flagella.

The dinoflagellate is easiest to detect when it's on the attack, triggered into action by an unknown substance secreted by fish. Then it transforms from one of its resting stages into a swimming cell that emits neurotoxins into the water and air.

The neurotoxins affect the fish's nervous system, causing it to become disoriented and lethargic and to gape for air at the surface. Unless a fish can escape, it will suffocate because its breathing mechanism is paralyzed. Fish can die within minutes of attack.

As the toxin affects the nervous system, the dinoflagellate attaches itself to the flesh and literally begins to suck the skin away. This releases organic matter into the water that attracts more dinoflagellates and sends the one-celled gametes produced by the parent cells into sexual reproduction.

Now the water is swarming with hungry dinoflagellates emitting more

Continued

neurotoxin and feeding on more fish. It's a horrific feeding frenzy even Stephen King couldn't imagine. The final result is a mass of floating dead fish.

To escape these microscopic monsters, fish and crabs often try to leave the water. Fishermen call these occurrences "fish walks" or "crab walks."

Those fish that do escape often don't live long. They carry too many battle scars — open, bleeding sores or holes eaten through their bodies that make them susceptible to other pathogens and bacteria, Noga says.

After the fish die, the killer dinoflagellate can make one of several transformations. It can encyst and settle to the bottom in a deceitful resting stage, Burkholder says. Or it can shed its flagella and become a nontoxic amoeba. Amoebas, shape-shifting multiarmed single cells, continue to leisurely feed on the fish carcass and other proteins in the water column or on the bottom.

Or the dinoflagellate can transform into asexual, nontoxic zoospores that swim in the water column and are attracted to areas rich in algae and nutrients, particularly phosphorus.

Because of its unusual transformations, some scientists and resource managers have doubted Burkholder's findings. But Karen Steidinger, a phytoplanktonologist with the Florida Department of Environmental Research and the Florida Marine Research Institute, says this dinoflagellate is for real.

"It is a very cryptic species, one that is difficult to identify because of the small size of the flagellated stages and its life cycle," Steidinger says. "Its amoeboid and cystlike transformations are life stages that most marine phytoplanktonologists would not associate with that of a dinoflagellate."

But no matter what it becomes — cyst, amoeba or zoospore — it can transform back into a killer, sometimes within minutes, in the presence of a school of fish.

Once they were able to identify the killer dinoflagellate, Burkholder and Noga documented its presence at fish kills in North Carolina and along the East Coast.

But was the toxic dinoflagellate a new organism, or had it been in our estuaries all along and never been identified? Burkholder believes it's the latter. Being such a primitive life-form, the dinoflagellate has probably existed for eons undetected. But Burkholder believes its abundance and visible effects — fish kills — may have increased in the last 50 to 75 years as the water quality in our estuaries has degraded because of increased agricultural and commercial development.

JoAnn Burkholder

In her NCSU laboratory, Burkholder tested 28 species of fish for susceptibility to the toxic dinoflagellate. None were immune to the toxin, although some species were more sensitive than others. Blue crabs, clams, scallops and young oysters are also affected by the toxin. She has yet to test shrimp or adult oysters.

Are there any human effects from this waterborne killer?

There are no certain instances of the dinoflagellate affecting fishermen, swimmers or boaters on the water.

But problems have occurred in Burkholder's laboratory where lab assistants and technicians have had prolonged and direct exposures to the dinoflagellate in its active, toxin-emitting phase. One of Burkholder's research associates was hospitalized after experiencing memory loss, disorientation and speech impediments. Burkholder, too, has suffered memory loss and disorientation.

Until the toxin is fully characterized by chemists, however, neither Burkholder's nor her research associate's problems can be fully understood. The N.C. Department of Health is investigating the human effects of this dinoflagellate, but results may be more than a year away.

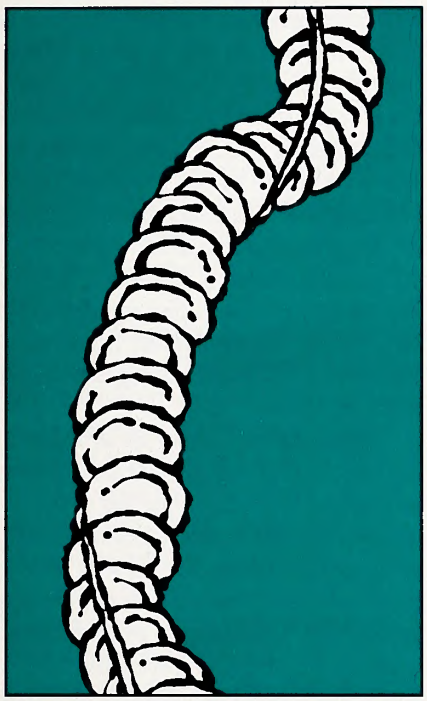
For now, Burkholder has these cautions for people who work and play on the water.

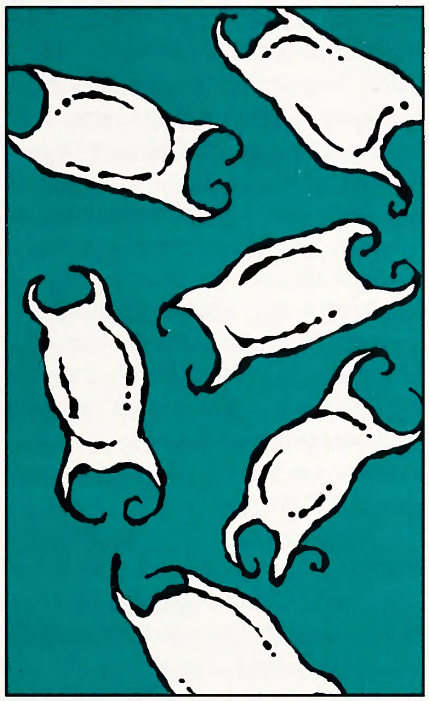
- Leave an area where fish are floating at the water's surface. A fish kill may be in progress, and the neurotoxins may be in the water and air.
- If you dip your hands or feet in an area where the dinoflagellate is active, immediately wash them with a 10 percent bleach solution. Bleach detoxifies and kills the dinoflagellate, Burkholder says.
- If you're a recreational fisherman, don't keep or eat fish that have visible sores or holes in the flesh.
- Don't eat fish that have washed ashore or beached themselves.

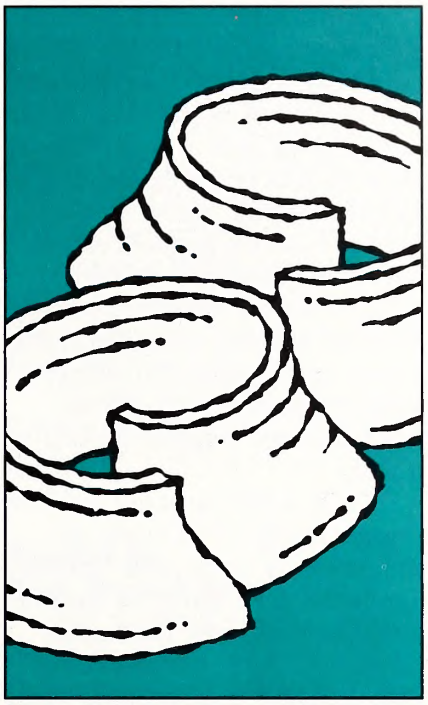
Consumers of seafood bought at retail outlets such as grocery stores, seafood markets and restaurants should not worry. Commercial fishermen would not harvest fish affected by the dinoflagellate because the unsightly sores make the fish unfit to sell.

To help researchers such as Burkholder and Noga learn more about this mysterious dinoflagellate, commercial fishermen and recreational water users are asked to report any fish kill they spot. Note the area where the fish are floating as exactly as possible, then leave. Do not take fish or water samples. Quickly call either the N.C. Division of Marine Fisheries at 1-800/682-2632, Burkholder's NCSU laboratory at 919/515-2726 or 919/515-3421 or Noga's NCSU School of Veterinary Medicine laboratory at 919/829-4393 or 919/829-4236.

What Are Those Things, Anyway?







An Egg of a Different Kind

Pretty shells aren't the only ocean gifts you'll find at the tide line. Egg cases of different sizes, shapes and origins commonly wash ashore along Tar Heel beaches.

A String of Whelk Eggs

Who would have thought that the hard-shelled whelk would begin its life in a necklace of eggs?

The mother whelk secretes a spiraling strand of parchmentlike oval sacs filled with eggs. After creating these egg cases, which can measure up to 2 feet long, the mother whelk attaches them to a shell or rock or buries one end in the subtidal sand. Often, however, the cases wash ashore after becoming dislodged by storms and waves.

Inside each sac are 20 to 100 eggs. Baby whelks, about the size of the dot over this "i," first hatch inside the sac, where they feed on other unhatched eggs and stored protein. After about two weeks inside the sac, the baby whelks chew their way out of the incubation chamber.

Each whelk hatchling emerges as a miniature version of its parents, with its tiny shell having only one whorl.

The egg sacs of different whelk species vary in shape. The sac edges of the knobbed whelk are flat and square; but the edges of the channeled whelk are sharp.

Devils' Pocketbooks

Coastal folks call them "devils' pocketbooks" or "mermaids' purses." Landlubbers often question the identity of the hard, black pouches that wash up along our state's beaches.

They're the egg sacs of skates, those fan-shaped marine critters with the long tail. The sacs are black, 1 to 3 inches long and rectangular, with a curly horn at each corner. The horns extract oyygen from the water and extrude wastes.

Inside each black sac is a single egg with a large yolk. Female skates are migrating inshore now to lay these eggs.

The underside of the sac is sticky and adheres to underwater plants. Hidden among the flora and protected by its leathery encasement, the embryonic skate develops, hatching three to 15 months later.

Each skate emerges as a miniature adult, ready to fend and feed for itself. Later, the egg sacs dislodge from their plant hosts and wash ashore.

Sand Collars

Looking like a detachable collar or the rubber cup at the end of a plumber's helper, the egg case of the moon snail has piqued the curiosity of more than one summer beach vacationer. These gray, rubbery collars are frequently found among the beach wrack of seashells, seaweed and organic debris.

Mother moon snails extrude their eggs in a jellylike sheet that is held together with mucus and sand. The collar shape is created as the eggy sheet wraps around the muscular foot of the mother moon snail.

By August, the egg case will dry, crumble and release about a half million young hatchlings to the ocean.

Kathy Hart

Summit Seeks Solutions to Sagging Oyster Production

Used to be, along Lockwood Folly River at autumn low tides, only one thing eclipsed the bounty of oysters protruding from the exposed mud and rock. That was the strong backs of oystermen bending to handpick or rake the harvest of the succulent shellfish. Nearby, the town of Varnum would prepare for its community oyster roast to showcase the indigenous harvest and celebrate its heritage. There and in similar settings throughout eastern North Carolina, you couldn't steam enough oysters to satisfy the hordes that came to sample this local delicacy.

Today, a different picture has emerged throughout the sounds and embayments of coastal North Carolina. The local oyster is seldom the center of community gatherings. The shellfish served at Tar Heel oyster roasts today likely traveled from Louisiana or Washington. Fewer bodies bend in silhouette to gather a shrinking harvest of *C. virginica*. Recruitment, or new population of oysters each season, is languishing. Disease and polluted waters, combined with poor management and overexploitation of the oyster fishery, have tainted this once prolific resource.

At the turn of the century, North Carolina produced around 5 million pounds of oysters each year. By the 1920s and '30s, annual production had declined to about 2 million pounds. During the past three years, the state's feeble production has barely reached 300,000 pounds, according to the N.C. Division of Marine Fisheries.

N.C. Sea Grant, the N.C. Division of Marine Fisheries and other partners sponsored a summit in April to discuss directions for boosting the sagging oyster industry. Experts from other states shared their experiences with participants.

Our state has much company in its oyster woes. The oyster harvest in Maryland and Virginia, which traditionally has been much higher than North Carolina's, has declined in recent years to about the same level. Total U.S. production in 1992 was almost 30 million pounds, with about 25 percent from the West Coast, mainly Washington; 30 percent from Louisiana; 20 percent from Connecticut; and the remainder from the East Coast and Gulf of Mexico.

North Carolina embraces a large area — about 1.8 million acres — available for oyster production. But North Carolina has less "oyster rock" or reef area than Virginia and Maryland. Also, the shellfish leased acreage in North Carolina is comparatively low — about 2,600 acres. Most states and countries that have increased oyster production have developed some type of culture/lease system.

Management of oyster production in North Carolina has lagged behind that of other states. Oyster seed beds under state management are very small. Individuals who lease shellfish bottom from the state are given little protection from poachers, which limits private investment. Oyster rock is on a very thin foundation; the addition of cultch — the hard substrate to which young oysters attach — has been limited.

And during the past five years, the ubiquitous oyster diseases Dermo and MSX have hurt viability. These ravenous protozoan or one-celled parasites first appeared in North Carolina's estuarine landscape in the late 1980s. Both Dermo and MSX thrive in warm, salty waters typical of tidal creeks and sounds during drought conditions. Harmless to humans, the parasites attack and eventually kill oysters. In 1989, the diseases ravaged North Carolina's oyster harvest, and according to scientists, are here to stay.

Research on oyster diseases has gained some momentum in the past few years with revived funding. With scientists at the Virginia Institute of Marine Science now able to culture Dermo in a laboratory, they can try to learn how to control the disease and circumvent it.

The disease infection cycle raises the possibility for innovative management to avoid mortality from Dermo, which compared to MSX, is a slow killer. Dermo will cause near total mortality in a crop of oysters infected for two summers. Where oysters reach market size in 18 months, some culturists have reversed the traditional planting cycle to limit exposure to Dermo, which is mostly a warm season phenomenon. Spat planted in the fall gets its first growth period as the water is cooling and Dermo is declining. The following spring, oysters pick up Dermo but aren't killed. The oysters are harvested at the onset of the second spring and spared lethal exposure.

Aquaculture, another focus of the summit, can substantially increase oyster production. North Carolina has developed its own innovative method of culturing oysters off the bottom with a grow-out system that resembles a floating ladder. The "chub ladder" method, developed by N.C. Sea Grant specialist Skip Kemp and a metal clip manufacturer, has been enhanced by cooperation of the N.C. Division of Marine Fisheries and 30 private oyster growers. The oysters grow at the surface in individual mesh bags sealed at both ends until harvest. This "Jiffy Pop" method of culturing oysters offers the advantages of low labor requirements; the system is mobile and easily retrievable.

Chub oysters reach market size in about 18 months, nearly half the time it takes in the wild. And because they grow near the water's surface, where oxygen and food are more plentiful, they tend to be healthier and less susceptible to diseases.

From the summit came a proposal for a "blue-ribbon committee" appointed by the Legislature to address the issues of rehabilitation and restoration, leasing and water access, seed availability, disease and aquaculture research, improved management and public image, and marketing. Sea Grant has produced a six-page summary of the Oyster Summit with recommendations. For a free copy, write Sea Grant at Box 8605, NCSU, Raleigh, NC 27695. Or call 919/515-2454.

Carla Burgess

Storm Drain Stenciling Targeted in 68 Cities

In August, North Carolinians will be pounding the pavement — and then painting it — with educational messages to keep storm drains clean.

It's all part of a stenciling campaign, sponsored in part by the Year of the Coast, to make people aware that storm drains flow to the Albemarle and Pamlico sounds, the Cape Fear River and other estuaries.

City managers and volunteer groups in 68 cities from Wilmington to Greensboro have been targeted to join the statewide campaign. Volunteers have been recruited from Girl and Boy Scouts, civic and 4-H clubs, N.C. Big Sweep, Keep America Beautiful programs and Stream Watch groups.

These groups will share 550 stencils custom-made for the particular coastal waters that their cities drain into. The stencils and other supplies will be distributed through city officials, who will also approve storm drains for painting.

The following cities were chosen for the first round of stenciling. Organizer Barbara Doll, Sea Grant's coastal water quality specialist, hopes to expand the effort inland next year.

- **Albemarle Sound**

Pasquotank River Basin: Columbia, Elizabeth City, Hertford.

Chowan River Basin: Ahoskie, Edenton, Rich Square.

Roanoke River Basin: Eden, Henderson, Kernersville, Plymouth, Reidsville, Roanoke Rapids, Roxboro, Williamston, Windsor, Yanceyville.

- **Pamlico Sound**

Tar-Pamlico River Basin: Belhaven, Greenville, Louisburg, Nashville, Oxford, Rocky Mount, Tarboro, Washington.

Neuse River Basin: Bayboro, Cary, Durham, Garner, Goldsboro, Havelock, Kinston, New Bern, Oriental, Raleigh, Smithfield, Wilson.

- **Cape Fear River**

Cape Fear River Basin: Asheboro, Burlington, Carrboro, Chapel Hill, Clinton, Dunn, Elizabethtown, Fayetteville, Graham, Greensboro, High Point, Rose Hill, Sanford, Siler City, Southern Pines, Southport, Wallace, Wilmington.

- **Other Sounds**

Atlantic Beach, Beaufort, Emerald Isle, Jacksonville, Morehead City, Swansboro, Carolina Beach, Kill Devil Hills, Kitty Hawk, Long Beach, Manteo, Nags Head, Surf City, Wrightsville Beach.

In addition to the Year of the Coast support, funding has been provided by the N.C. Division of Coastal Management and the U.S. Fish and Wildlife Service. For more information, write Doll at N.C. Sea Grant, Box 8208, N.C. State University, Raleigh, NC 27695-8208. Or call 919/515-5287.

Dr. Spence Goes To Washington

N.C. Sea Grant's marine education specialist will be sharing her talents with the National Sea Grant College Program office in Washington, D.C., beginning in September. Lundie Spence will help energize educational projects within the Sea Grant community and work with educators from other divisions under Sea Grant's parent organization, the National Oceanic and Atmospheric Administration. These include the National Estuarine Research Reserve and the National Marine Sanctuary programs.

With greater emphasis on national and regional educational programs, the national office needed help with its human resources program. Spence will fit that bill, working with projects such as Operation Pathfinder and the Global Change Project, a program that teaches nonformal educators about changes in sea level, carbon dioxide and ozone.

Spence will return to her berth in North Carolina in March.

Splish Splash Again

There's a renewed pool of resources for environmental educators. *Splish Splash*, N.C. Big Sweep's K-2 educational activity guide, has been reprinted and is being offered again to Tar Heel teachers.

The 44-page manual provides activities for young stewards on recycling, animal entanglement and plastics in marine and aquatic environments.

The reprint of the manual, first published in 1992, was made possible by funding from CP&L, Duke Power Co., ITW Hi-Cone and the N.C. Division of Environmental Management's Water Quality Section, which is within the state's Department of Environment, Health and Natural Resources.

To order, send $2 for postage and handling to Big Sweep, P.O. Box 550, Raleigh, NC 27602. Out-of-state orders are $3.

Kudos to Sea Grant Scientist

N.C. Sea Grant researcher JoAnn Burkholder recently received a 1994 Outstanding Research Award from the N.C. State University Alumni Association. The association recognized Burkholder for her devotion and dedication to research.

Burkholder is part of the Sea Grant research team that discovered the toxic dinoflagellate implicated in some fish kills in North Carolina estuaries and in other states (see story, page 19). She also has researched the effects of nutrients on submerged aquatic vegetation.

In addition to her research work, Burkholder serves on the N.C. Marine Fisheries Commission and the Coastal Futures Committee appointed by Gov. Jim Hunt to study the state's coastal management practices.

For her undergraduate studies, Burkholder majored in zoology and animal ecology at Iowa State University. She received her master's degree in aquatic biology at the University of Rhode Island and her doctorate in botanical limnology at Michigan State University.

"JoAnn is an outstanding scientist," says N.C. Sea Grant Director B.J. Copeland. "She is constantly pushing to

Continued

expand the scientific knowledge in her field, and her devotion to her work is unsurpassed. The scientific community could use more researchers with her drive and zeal."

A Sweeping Event

Get out the gloves, trash bags and data cards: 'Tis the season for Big Sweep.

The First Citizens Bank Big Sweep is set for Saturday, Sept. 17, from 9 a.m. to 1 p.m. at more than 450 sites from the mountains to the coast. It is the nation's largest statewide waterway litter pickup.

Last year, this grassroots environmental event attracted more than 12,000 volunteers statewide. In seven years of cleanups, Big Sweep volunteers have collected more than 1,000 tons of debris from beaches, lakeshores, riverbanks and creek beds.

This year, cleanup sites have been identified in more than 85 of North Carolina's 100 counties. Volunteers are needed at all sites. N.C. Big Sweep Executive Director Susan Bartholomew expects more than 14,000 waterway stewards to turn out for this year's event.

To volunteer, call the MCI Big Sweep hotline at 1-800-27-SWEEP between 10 a.m. and 6 p.m. weekdays. Hotline volunteers can direct you to the cleanup site or county coordinator of your choice. Individuals, families and groups are all welcome.

For children, Big Sweep provides a firsthand lesson in aquatic litter and its effects on the environment. Supervised groups of youngsters from schools, Scout groups, 4-H, churches and sports clubs can join the cleanup.

For adults, Big Sweep serves as a reminder that we are all stewards of our aquatic environments. Adult groups — civic organizations, garden clubs, church members, company employees, neighborhood organizations and trade associations — are also asked to lend a helping hand.

Besides bagging litter, volunteers also record their finds on data cards distributed by coordinators. Recording each piece of debris helps Big Sweep organizers determine who's leaving aquatic debris behind and how to direct future educational efforts.

Big Sweep strives to curb waterway litter because it's unsightly, harmful to people and deadly for critters that live and feed in our aquatic environments.

The theme chosen for this year's cleanup event is "You are the solution to water pollution." The upbeat, action-oriented message will adorn all cleanup event posters, brochures and T-shirts.

This year's T-shirt is black and available in adult sizes medium and extra large. The title theme and Big Sweep logo are contained in a rectangle bordered by aquatic critters. All are screen-printed on the shirt in vibrant colors — yellow, green, blue and red. The cost for the T-shirt is $12, and it can be ordered from N.C. Big Sweep, Box 550, Raleigh, NC 27602.

N.C. Big Sweep is the nonprofit organization that coordinates the annual waterway cleanup and sustains a year-round educational effort to reduce aquatic debris.

For more information about Big Sweep, call 1-800-27-SWEEP or 919/856-6686. Don't forget to mark your calendar for Sept.17 and join the First Citizens Bank Big Sweep.

Green Earns New Title

David Green, Sea Grant's seafood technology specialist, has been named an assistant professor in the Department of Food Science at N.C. State University. Green will also now head operations at the NCSU Seafood Laboratory in Morehead City.

As a result of additional state funding, the seafood laboratory has recently undergone renovations and staff expansion.

Exploring the Oceans

Until recently, oceans were explored through sampling by surface vessels or manned submersible vehicles. But these ocean exploration methods are slow, limited in the area they cover, expensive and sometimes hazardous at great depths. Consequently, the oceans remain a mysterious and largely unexplored frontier. Scientists are quick to note that we know more about the surfaces of other planets than the ocean depths.

Researchers first tackled the problem by designing and building unmanned tethered submersibles called remotely operated vehicles (ROVs). In many cases, ROVs work well and perform surveys, inspections and simple work tasks. But ROVs have limitations. The tether that connects the ROV to the surface ship for power and communication is easily entangled and produces hydrodynamic drag on the vehicle when it operates at greater depths.

Underwater explorers needed an unmanned vehicle with greater mobility and versatility. Hence began the work to design and build a free-swimming or autonomous underwater vehicle (AUV). The Sea Grant Program at the Massachusetts Institute of Technology (MIT) recently developed a prototype AUV, *Odyssey II*. It was built with components costing less than $75,000, weighs 350 pounds, can travel 170 miles at depths up to 3.7 miles and is the first deep-diving AUV to carry a sonar system and two acoustic navigation systems.

During March, *Odyssey II* undertook its first major scientific mission. The vehicle was launched from a hole cut in the ice at a site about 170 miles offshore of Prudhoe Bay on Alaska's northern coast. It made several runs beneath the ice, conducting preliminary tests and obtaining data on conductivity, temperature and depth before piloting itself back into a capture net at its point of entry.

In upcoming missions, plans call for *Odyssey II* to study hydrothermal vents on the Juan de Fuca Ridge off the Washington coast and on the East Pacific Rise west of Central America. The ultimate goal of Sea Grant's work on AUVs is to develop a network in which many low-cost AUVs operating interactively from remote sites will collect oceanographic data over greater areas and for longer time periods.

Carolinas' Book a Must for Serious Inshore Anglers

At first glance, the bookstore peruser might think that *Inshore Fishing the Carolinas' Coasts* is just another coastal fishing book. But on closer inspection, the fishing enthusiast will find this guide differs from others by covering the full range of inshore fishing opportunities. The book will be most useful to the novice or newcomer to the Carolinas who is interested in the array of inshore sportfishing choices. But even veteran anglers will benefit from new insights provided by the author, veteran angler Bob Newman.

Newman's book is organized around the most popular species that inshore fishing enthusiasts will likely encounter — spotted seatrout, bluefish, red drum, flounder, tarpon, king and Spanish mackerel, cobia and sheepshead. For each species, information is presented on life history, fishing tactics, hot spots and tackle. Newman also addresses various types of fishing, including pier, surf, boat and fly-fishing — and popular locations. The book is filled with useful tips on fishing tactics and methods. The author presents an easy and novel way to catch fiddler crabs — with a bucket and two boards — for use as sheepshead bait.

A chapter devoted to saving our coastal environment, although laudatory in its intent, seems out of place and is cursory in its treatment of the subject. For example, after the author describes problems with coastal wetlands and erosion, he devotes a section to the question, "What are we doing to stop this?" The only legislation he mentions is the Coastal Barrier Improvement Act of 1990 and the North American Wetlands Conservation Act of 1990. There are other laws that arguably have more impact. Other statements reflect personal opinion, but are presented as fact, such as, "State and local governments have never been greatly concerned about the environment." More appropriately, the discussion could have focused on activities such as tag-and-release, ethical angling and programs to curb marine debris. In these areas, anglers can have a direct impact.

An associated problem is the lack of references for the information presented. Proper referencing would have better documented these statements and provided a list for additional reading.

The six appendices provide good sources for more information. Topics include piers, licenses and regulations, bait and tackle shops, environmental organizations, guides, charter and head boats, marinas and boat dealers. The directories are not all-inclusive, but there are enough choices to get you started.

Despite these minor problems, the book is recommended reading for inshore anglers and should find a place on the bookshelf of all serious Carolina fishermen. *Inshore Fishing the Carolinas' Coasts* is available in bookstores or directly from the publisher: Down Home Press, P.O. Box 4126, Asheboro, NC 27204. The price is $13.95, plus 84 cents tax. Mail orders should include $1.50 for shipping. For more information, call 910/672-6889.

Get a Grip on Ocean Motion

After months of planning and saving, you have finally embarked on that long-awaited fishing and boating adventure. The skies are blue, the sun is bright and the sea is a little choppy. The captain tells you the fish have been biting and you should expect some real action.

Then it happens. As the boat leaves the harbor, your mouth starts to feel dry. Next comes yawning. Soon you start to sweat, even though your skin is cold and clammy. Next the queasiness begins, followed shortly by full-blown nausea. The rest is a rerun of breakfast. If you've felt these symptoms of seasickness, it might help to know that you are far from alone. Mal de mer affects nearly 90 percent of the population.

It might also help to know that you can get relief from a new Sea Grant brochure, "Get a Grip on Ocean Motion."

The brochure gives you options for preventing and treating seasickness.

First, you can adapt. Or you can take drugs, the most common way to treat seasickness. There are a variety of prescription and over-the-counter products to combat symptoms.

Also, there is acupressure. In the past few years, the use of pressure-point treatment for sickness has become popular.

And finally, diet is important. Some experts believe eating can lessen motion sickness. Learn what to avoid.

This brochure is intended to help you better understand seasickness. With the proper precautions, you can avoid its worst effects.

To order this free brochure, write N.C. Sea Grant, Box 8605, Raleigh, NC 27695. Ask for UNC-SG-94-01.

Emergency First Aid

When you cast off from the dock for a day on the water, emergencies are probably the last thing on your mind. But you must be ready for them, especially when boating. On the water, seconds count and there's no marine equivalent of an ambulance service short of the U.S. Coast Guard.

Sea Grant's "Emergency First Aid" manual is a must for boaters or anyone else who might have to stabilize an injury and provide early care before help arrives.

Recognizing that it's easy to panic during emergencies, this manual gives clear instructions for evaluating an injury and seeking help. It offers step-by-step descriptions and diagrams: what to look for and do for stopped breathing; choking; bleeding; shock; heat stroke and heat exhaustion; burns; marine stings; breaks, fractures and dislocations; and poisoning.

The U.S. Coast Guard suggests that boaters carry first-aid manuals and kits. Commercial fishermen are required to carry them.

The 11-by-8 1/4 inch manual is spiral-bound and opens flat for easy reference. The back page has space for important telephone numbers. Instructions are written in English and Spanish. The cost is $1.50. Ask for UNC-SG-94-03.

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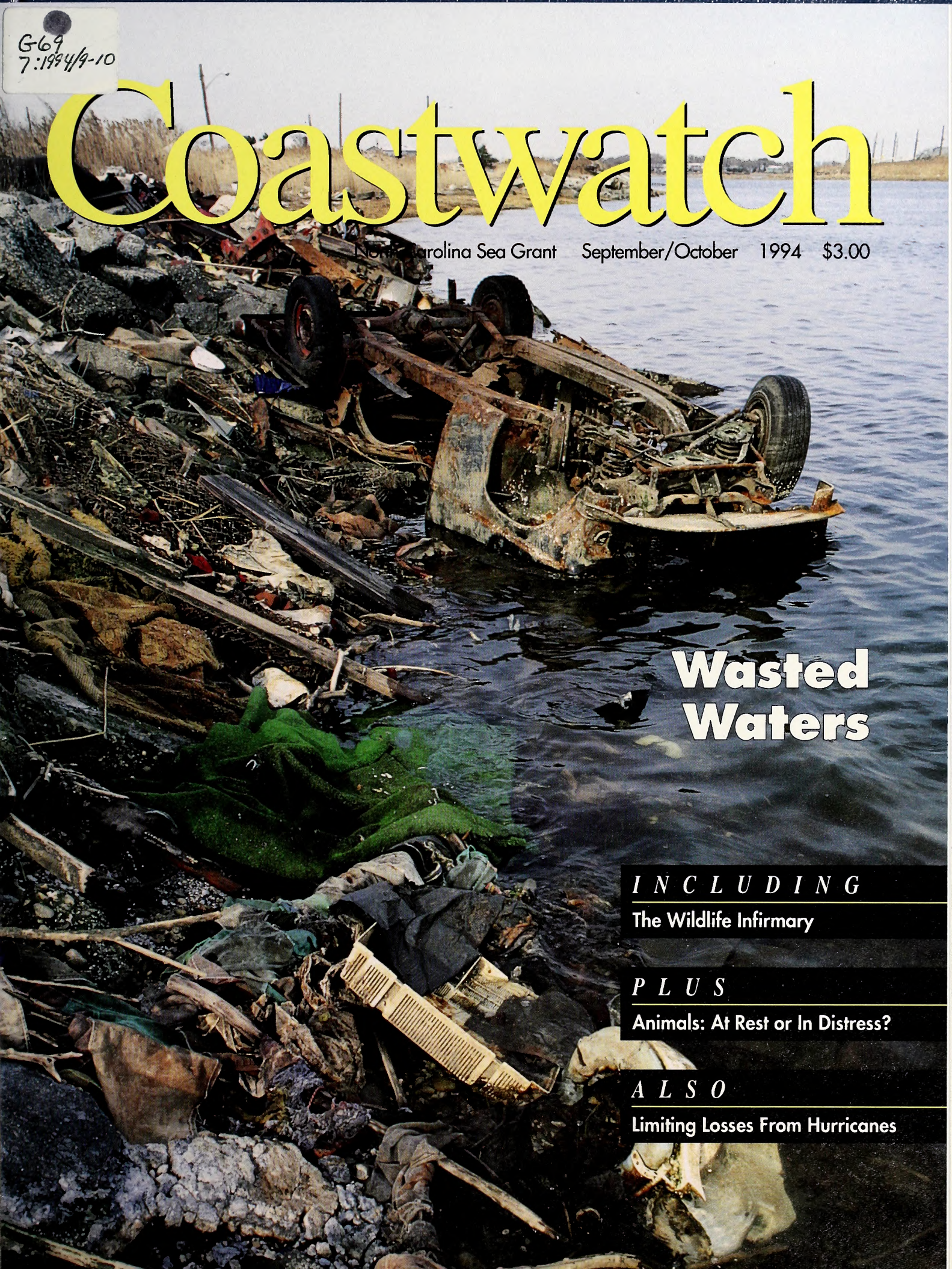

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, N.C. Sea Grant supports several research projects, a 12-member extension program and three communicators. B.J. Copeland is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

Coastwatch (ISSN 1068-784X) is published bimonthly, six times a year, for $12 by the North Carolina Sea Grant College Program, Box 8605, N.C. State University, Raleigh, NC 27695-8605. Telephone: 919/515-2454. Fax: 919/515-7095. E-mail: k_hart@ncsu.edu. Second-Class Postage paid at Raleigh, N.C.

POSTMASTER: Send address changes to *Coastwatch,* N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Front cover photo of marine debris by Don Riepe of the American Littoral Society.

Inside front cover photo of sand dunes on the central coast by Scott D. Taylor.

Printed on recycled paper by Highland Press Inc. in Fayetteville, N.C.

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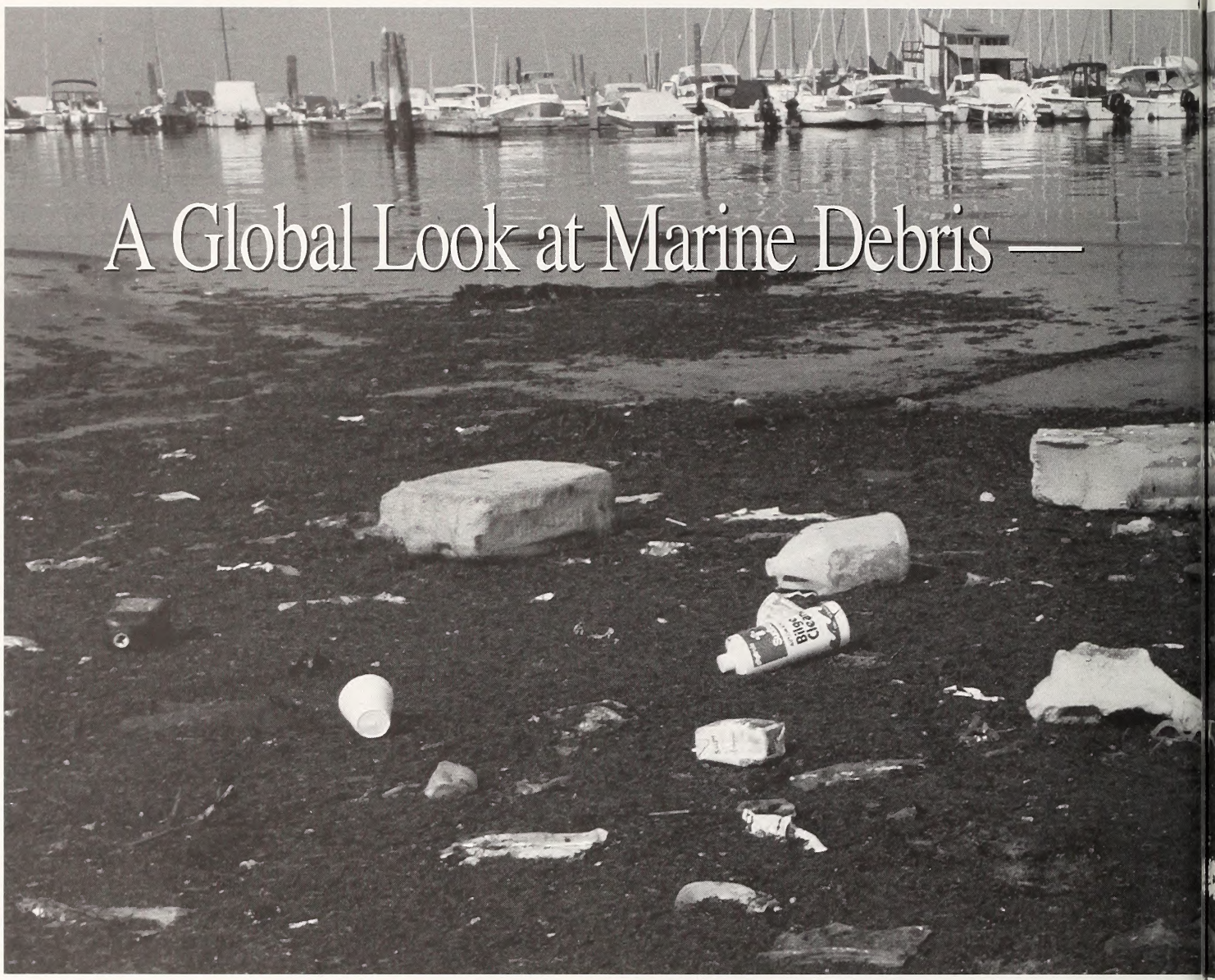


Litter mars the shoreline of this New York harbor.

By Jeannie Faris and Kathy Hart

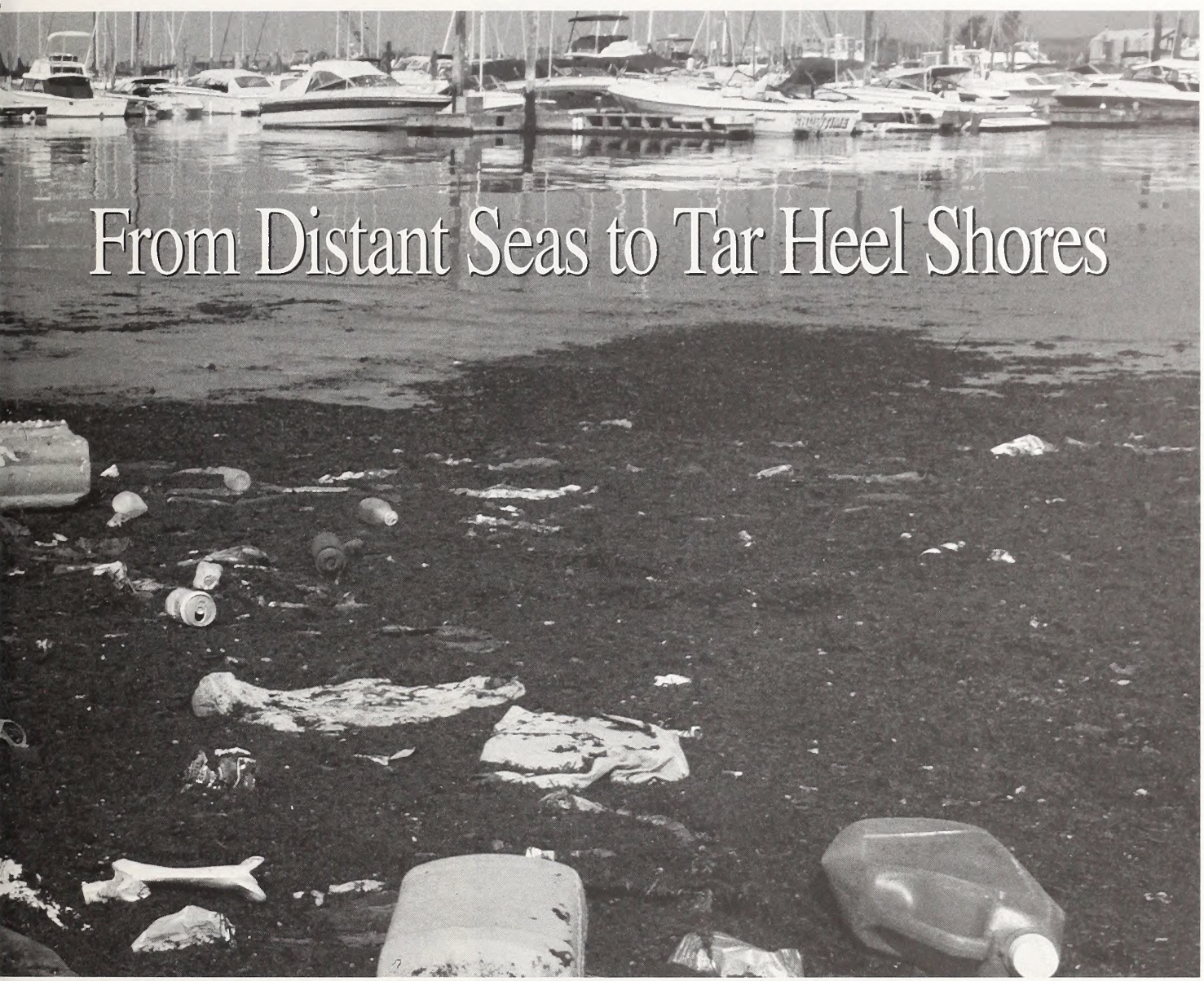
For one day each year, the shores of North Carolina waterways are scoured free of trash by the ton. But it's never long before these sands and banks are littered again. Someone drops a drink can on a lake; street trash washes into a creek through a nearby storm drain; waves redeposit drifting debris on a beach; an abandoned tire sinks into a riverbank.

North Carolina, in this respect, is like any other part of the world. Marine debris reappears in waters and on shores just as predictably as the next turn of the tide. Cleanups aim to protect humans and wildlife from the dangers and discomforts of litter. But no amount of cleaning will kick the problem until people understand the full impacts of marine debris — on aesthetics, economics, public health, wildlife and the environment — and alter their behavior.

Globally, 221,513 cleanup volunteers collected 5.2 million pounds of debris last year. Sixty percent was collected in the United States. North Carolinians collected 231 tons of litter — 25 tons less than 1992 — during Big Sweep's statewide waterway cleanup, signaling that Tar Heels are getting the message and dropping less trash.

There are, however, people who continue to treat our waters and shores as dumping grounds. A myriad of state, federal and international law has evolved in response. But in North Carolina, anti-littering laws are complex and confusing to users and even enforcers. Many fall short of clearly distinguishing authority or supplying adequate resources, according to a 1991 N.C. Marine Science Council report on debris. There are important opportunities for new laws in our state, especially those that create incentives for reducing the waste stream and increasing waste recovery.

From Distant Seas to Tar Heel Shores



Don Riepe/American Littoral Society

But before the problem can be solved, the public must consider marine debris an important issue. And industry, especially businesses that contribute litter, must be convinced that reducing and managing waste is economically smart and civically responsible.

The Third International Conference on Marine Debris, organized by the National Marine Fisheries Service during May in Miami, Fla., took a wide-angle look at these and other waste issues to steer future efforts to restore polluted waters worldwide. It brought together scientists, resource managers, cleanup organizers and water users to discuss the problem and possible solutions.

Below are some of the insights gleaned from conference presentations and discussions.

Amounts, Types and Distribution of Marine Debris

Marine debris darkens all of the world's oceans, but the problem hardly starts there. Close to 80 percent is washed, blown or dumped from shore. In the entire marine debris debate, no other point is so straightforward.

The types of debris that float in world oceans are as varied as the cultures that generate them. Ships, winds and ocean currents carry debris in aquatic traffic patterns specific to each region of the globe. Waterborne trash off the Gulf of Mexico, for instance, will travel at different speeds and directions than it would off the coast of Australia or the Mediterranean. Consequently, worldwide responses to marine debris are as diverse as the languages that give them voice.

In the United Kingdom, sewage-related items have repeatedly washed up on beaches, prompting lawsuits and legislation to control them. China and Africa need more and better port reception facilities to dispose of shipping wastes. Likewise in the Caribbean, communities

Continued

Texas Sea Grant

Water collected in storm drains often pours directly into nearby streams.

also lack adequate collection and disposal systems for household wastes. The United States contends with wastes that run the gamut from sewage items to commercial fishing trash to recreational litter. Sunbathers toss cosmetic containers onto Mediterranean beaches, while paint chips accumulate on the seafloor in the wake of heavy shipping traffic. Many of the same debris problems can be found in the Southern Hemisphere — Australia, New Zealand and South Africa — but they are complicated by the vastness of the waters there, strong winds, currents and sinks that collect trash on the seafloor.

From this cursory look around the world, a few conclusions can be drawn. Developing countries need to improve their waste collection systems in port and on land, while industrialized countries should control infrastructure failures and trash left by tourists, boaters and other upland sources.

So the question becomes, how do we tackle marine debris globally when the problem is so different worldwide? The fractured nature of the problem doesn't lend itself to a standard approach. Rather, the problems and solutions appear to be country-specific.

The answer — a resounding chorus from scientists, resource managers and concerned citizens of all tongues — is a global commitment to measure marine debris and its impacts, trace its sources and stop it in its path.

But before the problem can be solved, the public must consider marine debris an important issue. And industry, especially businesses that contribute litter, must be convinced that reducing and managing waste is economically smart and civically responsible.

Worldwide, we share a historical perspective of the ocean and other large bodies of water. For centuries, we viewed them as dumping grounds for waste. Trash was heaved overboard from ships and still is, despite the London Dumping Convention and the International Convention for the Prevention of Pollution from Ships (MARPOL). It has been dumped onto beaches, into creeks or rivers or just thrown away in coastal areas and washed into the sea. It has drained from countless inland sources.

But not until the 1970s was marine debris launched as a global issue. Since then, we have picked up, counted, weighed and measured shoreside garbage. We have exposed the condition of trashy beaches. And we have learned about the types of litter in our seas and how they affect communities of humans, animals and even plants.

Plastics have emerged as the dominant problem worldwide. Still, our understanding of marine debris is incomplete. Twenty years into our research, efforts to identify sources are still crude. And only a few studies have looked at sources with an eye toward tracing trends and reducing debris. Collecting data on waterborne garbage for the sake of having data isn't enough. Nor are

beach cleanups a cure-all — at best they are a temporary fix to a complex and persistent problem.

Clearly, we need a new strategy. Monitoring must change to aggressively track sources and identify trends. It should tell us whether our pollution-control policies — education and regulations — are working. Are ships complying with MARPOL Annex V, the international pact that prohibits overboard dumping of plastics and regulates at-sea disposal of other garbage? Are land-based sources of debris changing?

In 1988, the United States ratified MARPOL Annex V. Since then, however, surveys and studies have been unable to measure the force of this legislation on U.S. shores. No consistent decline in the abundance of trash has been observed; nor have any nationwide trends emerged for plastic debris.

Likewise, there is little data on land-based sources.

Studies have found, however, that plastics account for most debris (48 to 99 percent) on U.S. beaches and harbors. Marine litter was examined from 1989 to 1993 by the Center for Marine Conservation annual cleanups, National Park Service quarterly beach surveys at eight parks, a National Marine Fisheries Service debris study in Alaska and Environmental Protection Agency surveys of 10 U.S. harbors.

Marine debris darkens all of the world's oceans, but the problem hardly starts there. Close to 80 percent is washed, blown or dumped from shore. In the entire marine debris debate, no other point is so straightforward.

In most locations, these studies found that plastics were dominated by packaging (bottles, bags and lids) or miscellaneous debris (fragments and pellets). Alaska was the exception with derelict fishing gear (floats, trawl web, rope) appearing as 53 percent of the litter. Beaches on the Gulf of Mexico were most trashed, followed by those on the West and East coasts. Among the park studies, Padre Island National Seashore on the Gulf of Mexico had the most debris; Assateague Island National Seashore on the East Coast, the least.

Kurt Byers/Alaska Sea Grant

Nets are sorted at an Alaskan harbor for recycling.

All locations harbored debris that could harm wildlife or human health. Rope was the most abundant entangling threat to wildlife, while plastic fragments (beaches) and pellets (harbors) were the greatest ingestible threat. Human health hazards were most commonly found on the East Coast, where sewage and medical debris turned up on beaches. The West Coast was relatively clean of these types of debris.

Countries that contributed debris to U.S. shores included Mexico, Canada, Japan, Taiwan, Korea and Russia. Much of the fishing gear (gill nets and gill net floats) on Alaska beaches originated from foreign (Japan, Taiwan, Korea) fisheries.

Impacts of Marine Debris

Marine debris is like the flu. It affects everybody at one time or another. But it creates the worst problems for those who are already unhealthy — particularly endangered species. Waterborne litter is yet another form of pollution that damages the carrying capacity of certain species.

And like the flu, there is no quick cure for marine debris. The impacts are very difficult to measure; the sources, hard to trace. Researchers often find that sources and impacts are separated by hundreds or thousands of miles since debris can travel great distances.

Scattered records of interactions between marine debris and wildlife date back several decades before the 1970s. Entangled northern fur seals were spotted as early as the 1930s. By the 1960s, various seabirds were found to have plastic in their stomachs. But not until a

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decade later, when floating plastic particles were found throughout the north Atlantic Ocean, were the potential problems fully recognized.

Today, we separate the impacts into two broad categories: biological and economic.

Biological studies tell us that waterborne debris casts a wide net of impact over marine and littoral animals, plants and perhaps even entire ecosystems. It entangles wildlife, masquerades as a food source and smothers benthic and beach plants.

The most obvious of these biological impacts is entanglement, although it is also difficult to measure. We get fleeting glimpses of entangled animals from planes and ships, but these cases are not well documented or systematically surveyed. Many victims die and sink or are eaten; others float under debris. Consequently, entanglement data is collected on the beaches where survivors strand or congregate to nest, away from the actual problem.

Worldwide, at least 135 species of marine vertebrates and eight invertebrates have been reported entangled in marine debris. Still, the measured frequency is low — usually less than 1 percent of an affected species — especially when compared to ingestion. These rates may, however, exceed estimates from land-based observations.

For certain species, entanglement appears to occur regularly.

Some — gray whales, California sea lions, northern elephant seals, northern gannets, herring gulls and shags — have healthy populations that don't seem to be compromised by low levels of entanglement deaths. This is not true, however, for endangered or threatened species — manatees, Steller sea lions, hawksbill sea turtles and olive ridley sea turtles. Even though entanglement deaths may be low compared to other human-related causes, they add obstacles to recovery. And for a few species — Hawaiian monk seals, green sea turtles and northern fur seals, certain fish and crabs caught commercially, and perhaps northern right whales — it occurs often enough to affect population numbers.

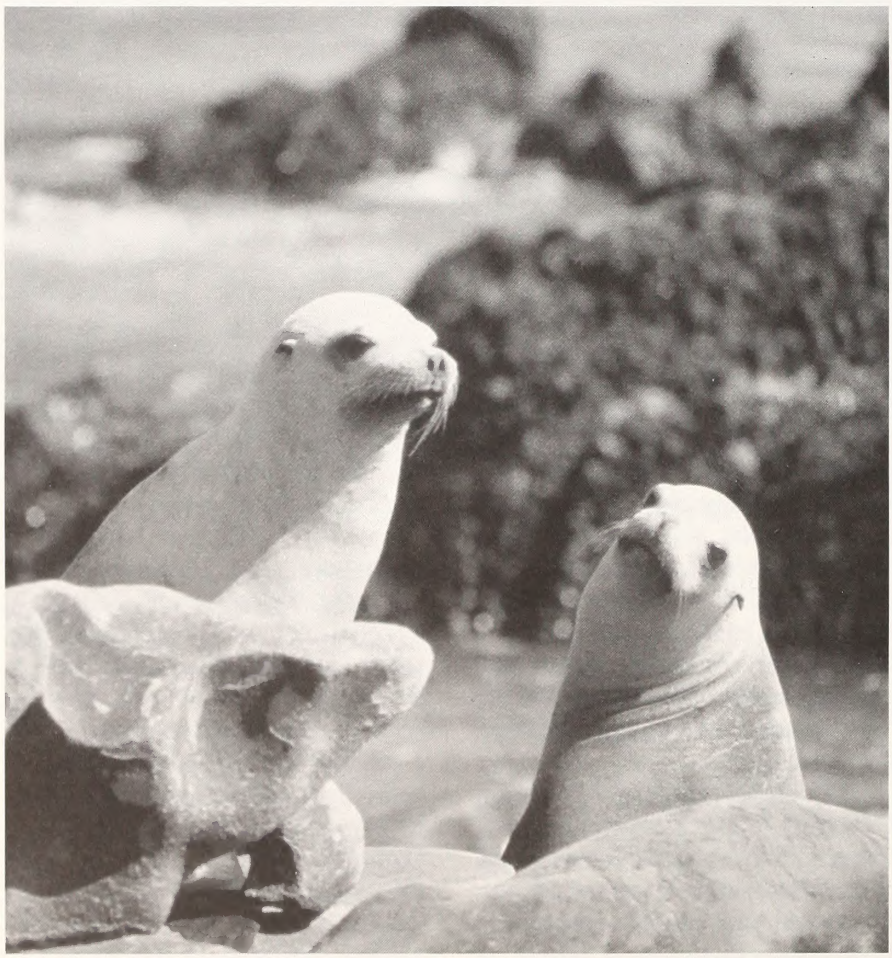
The answer — a resounding chorus from scientists, resource managers and concerned citizens of all tongues — is a global commitment to measure marine debris and its impacts, trace its sources and stop it in its path.

The frequency of entanglement is influenced by the density of debris in an area and an animal's food preferences, feeding habits and behavior. Young seals, for instance, like to play with debris; birds use it to build nests; and turtles often become entangled in debris that they're trying to eat. The shape and size of debris also have a bearing on its ability to trap animals. Nets and ropes, monofilament line, strapping bands and other ring-shaped objects are common culprits. Large items can trap animals, drowning air-breathers, asphyxiating fish that require motion to respire, starving them or making them vulnerable to predation. Smaller debris drags from the bodies of entangled animals, increasing the energy they need to move around and reducing their ability to forage and escape predators.

More commonly, however, animals eat plastic rather than become trapped in it. Plastic in the water looks like food to many of them. Turtles mistake bags for jellyfish, one of their favorite meals. Birds mistake pellets for fish eggs.

Other times, plastic is eaten in association with food that has been dumped from ships or consumed within contaminated prey.

At least 160 species of vertebrates — approaching 100 percent of some



California Sea Grant

Sea lions along the coast in California.

Scott D. Taylor

Because of their numbers, recreationists are seen as major contributors to the marine debris problem.

seabird species — and two invertebrates have been reported to ingest debris. But it's unclear whether ingestion is a more serious threat than entanglement because the effects are largely unmeasured. Seabirds and turtles appear to be more affected than mammals.

Ingestion is perhaps best understood for seabirds, which are at risk of eating debris because of their generalized diets and foraging at the water surface. Petrels, storm-petrels, phalaropes and some albatrosses and auks rarely regurgitate indigestible pellets; rather, they accumulate large loads in their digestive systems.

Turtles are also likely to eat debris because of their indiscriminate feeding habits. And once they've swallowed a piece of trash, the papillae lining their esophagus prevents regurgitation.

Turtles, birds and marine mammals that eat debris suffer a variety of ailments. Debris damages the digestive track; causes starvation by blocking food and increasing buoyancy in turtles; creates a false sense of satiation, affecting their long-term fitness and ability to grow, molt, reproduce and survive adverse conditions; and perhaps releases toxic pollutants as they digest. Physical damage from sharp items appears to be rare and an unlikely threat to significant proportions of marine animals. Digestive tract blockages usually occur in turtles, the West Indian manatee and some cetaceans, but it's hard to estimate the proportion.

Plastics have emerged as the dominant problem worldwide. Still, our understanding of marine debris is incomplete. Twenty years into our research, efforts to identify sources are still crude. And only a few studies have looked at sources with an eye toward tracing trends and reducing debris. Collecting data on waterborne garbage for the sake of having data isn't enough. Nor are beach cleanups a cure-all — at best they are a temporary fix to a complex and persistent problem.

An unknown and perhaps large portion of debris eaten by turtles and mammals is excreted. But it can kill an animal that swallows large or several items that block the intestinal tract.

On the economic side of impacts, we know that waterborne debris fouls ships and other marine equipment, competes with fishermen when castaway gear continues to "ghost fish," reduces the value of fisheries products and causes loss of tourism and recreational business. These impacts have only recently emerged from behind the considerable shadow of biological impacts, but they are much easier to measure. We look at them in terms of financial costs.

There are hundreds of reasons why marine debris is a problem, each with a common refrain: debris is not a natural part of the marine system. It hurts aquatic animals and plants. And it hurts beach communities and fishermen trying to make a living from the sea. As

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good as the reasons may be for reducing waterborne debris, however, they are not enough to bring about widespread change in behavior. Only hard data showing the extent of the impacts will give marine debris standing among the scores of other pressing environmental concerns.

Recreational Debris

Our oceans offer more than tonight's dinner or a highway for global travel. They provide hours of fun for boaters, recreational anglers, divers and beachgoers — everyone from the sunbather to the surfer to the camper.

But in pursuit of sun, fun and ocean spray, recreationists often leave behind or toss overboard the byproducts of their day on the water or at the beach. Boaters often toss ice bags, food wrappings and eating utensils into the water. Likewise, anglers drop discarded fishing line, bait bags, floats and lures overboard. Landside, beachgoers leave behind the trappings of their picnics, the contents of their coolers or the byproducts of their leisure — surfboard wax, suntan lotion bottles, ear plugs and toys.

Because of its sheer numbers —70 million boaters in the United States, 4 million certified scuba divers worldwide, 250 million American anglers and untold millions who visit beaches from the Mediterranean to Australia to the United States — this group offers resource managers a tremendous challenge. In many countries, including the United States, recreationists are potentially the number one source of marine debris. Although no reliable data exist for the amount of litter they generate, their numbers alone make them suspect.

Marine debris is like the flu. It affects everybody at one time or another. But it creates the worst problems for those who are already unhealthy — particularly endangered species. Waterborne litter is yet another form of pollution that damages the carrying capacity of certain species.

Discarded rope and netting from commercial fishing lodge on rocky Alaska shores.

As daunting as their size is their diversity, varying from the owner of a multimillion-dollar yacht to the angler fishing for his next meal. And few recreationists belong to organizations such as fishing clubs, dive organizations and boating groups where they can be collectively reached with information. Their diversity and lack of structure can mean only one thing. Efforts at controlling recreational debris will have to be multifaceted and individualized.

But efforts must be made. Resource managers agree that recreational litter has the likelihood for the greatest impact on wildlife because of where it is discarded. Most recreational activities occur near shore, the area where wildlife concentrations are greatest. The combination of wildlife and litter is often a deadly one, especially when litter such as fishing line and plastic bags are involved.

Size, diversity and impacts aside, recreational users have one common bond — their love of the environment

Kurt Byers/Alaska Sea Grant

they recreate in and, in some cases, the animals that inhabit it. This commonality may be the basis for reaching this group and for gaining the cooperation needed to reduce recreational marine debris worldwide.

Economic research has shown that people value clean recreational beaches even if they don't use them yearly. According to a resource valuation study by Duke University economist Kerry Smith, a Sea Grant researcher, people surveyed in North Carolina and New Jersey indicated a willingness to pay extra income taxes or user fees to keep beaches litter-free. And their willingness to pay was not affected by how frequently they visited. Those who hadn't seen a sandy shoreline in more than a year prior to the survey were just as eager to reach for their wallets as those who had dipped their toes in the sand within the last 12 months.

The study indicates that people value their leisure time and the environment where they recreate. When they do have time to cast a line, hoist their sails or roll out their beach towels, they want the area to be as pristine as possible and, if need be, they'll pay for the pleasure.

An array of actions must be employed to address the problem of recreational marine debris. Although many reduction efforts will be directed at recreationists, there are upstream points of intervention — product design, product packaging, retail methods, legal actions, education — for eliminating recreational debris. Debris management doesn't have to focus only on waste once it is produced.

Once discarded, six-pack rings pose an entanglement danger for wildlife. ITW Hi-Cone, a worldwide manufacturer of plastic six-pack rings, has tackled the problem at the product design and manufacture stage. Hi-Cone first designed a photodegradable six-pack ring that degraded in four to five weeks under average sunlight conditions. Then the company incorporated tear tabs so that each ring could be broken when the can is removed. Hi-Cone realized that people could not be depended upon to always dispose of their product properly, so they worked at ways to modify their product design to reduce its potential impact. More manufacturers of common marine debris products should use their design expertise to look for solutions.

But clearly, product design cannot eliminate marine debris; it can only lessen the impact. The burden still lies squarely on the shoulders of product users. People must understand that their

Size, diversity and impacts aside, recreational users have one common bond — their love of the environment they recreate in and, in some cases, the animals that inhabit it. This commonality may be the basis for reaching this group and for gaining the cooperation needed to reduce recreational marine debris worldwide.

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Don Riepe/American Littoral Society

Rain washes garbage into wastewater catch basins.

product wastes — bottles, cans, cups, plastic wrappers and bags — should not be discarded in the marine environment.

Vessel Debris

Since the onset of ocean travel, world sailors have used the seas as a vast, seemingly bottomless garbage dump. But today, we understand that the oceans are not limitless trash pits, especially where nonbiodegradables such as plastic, glass and aluminum are concerned. The debris that is dumped into marine waters can damage sensitive ecosystems.

Realizing the global environmental impacts of marine debris and targeting the commercial maritime users who ply the seas, the United Nations' International Maritime Organization (IMO) drafted a treaty — MARPOL and five annexes — designed to halt at-sea disposal of wastes, particularly plastics.

Annex V specifically prohibits the at-sea disposal of all plastics. It also limits the ocean discharge of other types of garbage to specified distances from land and prohibits it entirely in designated "special areas" such as the Baltic Sea, the Caribbean and the Gulf of Mexico. The at-sea disposal restrictions apply to commercial vessels of all types and size, including merchant ships, freighters, cruise liners, commercial fishing vessels, naval ships, ferries, research vessels, tugboats, barges and offshore petroleum platforms.

Sixty-eight countries had adopted Annex V as of June 1994. Once a nation ratifies this annex, the ships that bear its flag and navigate its shores must comply with the guidelines. Additionally, the country must provide adequate port reception facilities for the disposal of ship wastes.

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Vessels complying with MARPOL Annex V have three options. The boat or ship can legally dispose of nonplastics at sea. It can incinerate its wastes onboard. Or it can hold trash for disposal shoreside at ports or terminals.

Wisely, the IMO realized that vessel debris wasn't just the responsibility of the commercial maritime community. Shoreside, ports, terminals and docks must provide bulk containers to receive the increased quantities of garbage now being retained by ships and boats. Beyond that, the municipalities and governments that support these ports and docks must have waste management systems for final disposal of the garbage.

But despite the best laid plans of the IMO, vessel debris remains a problem. Many nations have not yet been ratified MARPOL Annex V. Developing countries often don't have the facilities and stable economies needed to support the treaty. That's why the IMO, World Bank and United Nations Environment Pro-

gram have worked to establish funding, cooperative agreements and regional programs and initiatives aimed at providing cost-effective methods for handling vessel debris.

In many cases, individual vessel operators choose to ignore the restrictions of the international treaty, claiming they don't have adequate equipment, space or personnel to hold or dispose of their wastes properly. Others claim ignorance. Positively, however, many collectively owned vessels, such as cruise liners and shipping vessels, are being forced by company policy to adhere to MARPOL Annex V. In some cases, these companies are financing new technology to handle shipboard wastes.

Despite the feel-good reward of doing the right thing, there are few incentives for vessel compliance and virtually no repercussions for noncompliance. Enforcement responsibility rests with the ratifying country, and in virtually all countries this enforcement is cursory.

Worldwide, coastal cities are a major land-based source of ocean litter. Urban debris washes off city streets, overflows from waste treatment plants during heavy rains and drains from industries. The debris varies from the cigarette filter tossed on the sidewalk to the plastic tampon applicator improperly flushed down the bathroom toilet to resin pellets used in the manufacture of plastic.

If little is done to enforce waste restrictions, then survey methods must be developed to link the debris that washes ashore with its source. In the case of debris items such as foam cups and beverage cans, the sources are ubiquitous. But other items can be tentatively linked to their sources.

Israeli officials place trash bins along shore for litter collection.

Salt bags, bait boxes, fish baskets and net floats are associated with commercial fishing. Small containers of toiletries, shoe polish and plastic cups are indicative of cruise line garbage. Hard hats and plastic write protection rings used in seismic testing are characteristic of the offshore petroleum industry. And other debris — wooden pallets, plastic sheeting and galley wastes such as vegetable sacks and egg cartons — are used by many oceangoing vessels and typically categorized as ship debris.

But making these linkages requires more than speculation. Sound data are needed from beach surveys, observer programs and surveillance efforts to directly connect debris to its source. Only then can resource managers begin the effort to educate and regulate specific segments of the maritime industry.

Urban Sources

Urban means city, city means people, and people mean trash. Add an adjacent ocean to the equation, and trash means marine debris.

Worldwide, coastal cities are a major land-based source of ocean litter. Urban debris washes off city streets, overflows from waste treatment plants during heavy rains and drains from industries. The debris varies from the cigarette filter tossed on the sidewalk to the plastic tampon applicator improperly flushed down the bathroom toilet to resin pellets used in the manufacture of plastic.

Unfortunately, despite the technological and educational efforts of governments, many of these debris items ultimately drain into coastal waters where they form floating webs of wastes or wash ashore to mar beaches.

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Phyllis Grifman/Southern California Sea Grant

Education is the key to teaching these Catalina, Calif., boaters and others about the dangers of marine debris.

Like other litter sources, resource managers don't know exactly what percentage urban wastes contribute to the overall problem. In many cases, city litter is indistinguishable from vessel debris or recreational byproducts. Only a few items — tampon applicators, condoms, syringes and resin pellets — can be directly linked to the sewage overflows and industrial wastes indicative of urban wastes.

Despite the lack of data, urban refuse is nonetheless considered a major marine debris contributor, especially in coastal waters adjacent to major cities. For example, the Environmental Protection Agency's Floatables Action Plan for New York/New Jersey Harbor removed more than 1,000 tons of floating debris from harbor waters in 1993. Meanwhile, New Jersey's Operation Clean Shores swept 5,700 tons of trash from 67 miles of nearby New Jersey beaches in the same year.

And while urban debris poses some of the same problems — wildlife entanglement and ingestion, visual eyesore, navigation hazards, vessel damage — as trash from other sources, it also elevates the potential for human health threats. Because city wastes sometimes contain used syringes and other medical wastes, potential does exist for disease transmission.

Everyone — the citizen, the factory owner, the legislator, the regulator, the enforcement officer and the educator — should examine the marine debris continuum to see where he or she can make a difference.

Also, medical wastes create economic problems when it washes ashore. Although beachgoers will tolerate shores littered with cans, foam cups and fishing line, they stay away from beaches contaminated with used syringes and vials of blood, even if these medical wastes are present only in small quantities. In the summers of 1987 and 1988, New York and New Jersey beaches were littered with small amounts of medical debris. Because of the publicity generated by these washups, people stayed away from these beaches by the droves, costing the New York/New Jersey economy almost $2 billion in lost revenues.

Since then, state, federal and local governments in the United States have initiated programs in cities such as New York and Miami to reduce urban debris. They've beefed up stormwater management efforts, launched adult and youth educational campaigns, employed new and old technologies to sweep streets and skim waters, promoted recycling and reuse, instigated industrial cleanup programs and begun volunteer beach debris pickup efforts.

But urban marine debris persists. And if the problem is bad in an industrialized country such as the United States where the money and technology exists to curb its flow, then the magnitude of the problem in the urban cities of developing countries is unfathomable.

Where does the debris come from? Primarily, three sources.

In some cities, stormwater sewers are connected to municipal wastewater treatment systems. As a result, heavy rains can cause the capacity of wastewater treatment plants to be exceeded. When this happens, nondegradable debris and raw sewage bypass the treatment process and flow into coastal rivers and bays. Resource managers call this combined sewer overflow.

Storm water itself is another source of ocean litter. Rains often wash trash — cigarette filters, foam cups, plastic wrappers and toys — directly into coastal waters or into storm drains that dump into oceans and coastal rivers.

Finally, malfunctioning sewage treatment plants and improper industrial waste management result in urban marine debris. The tiny plastic resin pellets that are ubiquitous in the world's oceans and on beaches are examples of industrial mishandling.

But urban marine debris can be reduced or eliminated at four points in its lifeline — source generation, on-land management, transport and deposition. The reduction actions include source reduction, improved industrial and municipal wastewater management and cleanup of waterways and beaches. And to accomplish these actions, resource managers can use a variety of tools — technological improvements, legislation, education, economic incentives, enforcement and increased funding.

Source reduction is the most cost-effective way to remove urban debris from the waste stream. Manufacturers can help by reducing packaging, altering product design and using less environmentally harmful and/or more easily recyclable base materials. If you can't stop it at its source, then proper waste disposal becomes the next logical place to stop debris flow into coastal waters. Finally, removing refuse from surface waters, shorelines and ocean bottoms is the last, most costly and most resource-intensive point at which to stop marine debris and lessen its impact.

Education must be a significant component of an effective urban marine debris control program. The residential, commercial and industrial communities should be educated to understand the importance of debris control. But when education doesn't work, enforcement agencies should stand ready to force compliance for all offenders.

Municipal governments across the globe must come to realization that source reduction, waste management, debris removal, education and enforcement cost money and time. The public, industry and all levels of government must recognize the need for action. Citizens must be willing to alter their behavior, and municipal governments and industry must be willing to change their wastewater management practices and consider alternative technologies. And when all else fails, government must step in with regulations and enforcement efforts to stem the tide of marine debris.

Everyone — the citizen, the factory owner, the legislator, the regulator, the enforcement officer and the educator — should examine the marine debris continuum to see where he or she can make a difference.

STENCILING AS A "KEEP CLEAN" REMINDER

Drop a wrapper or drink bottle into the street and chances are it will eventually wash into the nearest storm drain. No longer an urban eyesore, this litter is headed someplace where it will spoil more than the view.

It's flowing into a nearby creek, stream or river.

Many people don't know that storm drains are, in effect, garbage gateways from city streets to local waters. Rainwater washes along neighborhood gutters and into the drains, carrying antifreeze, motor oil, cigarette butts, paint, plastic, yard wastes and anything else in its path. These wastes never visit a treatment plant before journeying to the coast, doing untold damage along the way to wildlife, human health and safety, and even businesses that rely on clean waters.

Storm drain stenciling is one solution to this problem. By painting drains with a "Keep Clean!" message, volunteers throughout North Carolina are alerting passers-by that only rainwater belongs in these drains, says Barbara Doll, N.C. Sea Grant's coastal water quality specialist.

Doll organized the N.C. Storm Drain Stenciling Project as a Year of the Coast activity. It was launched in September by Gov. Jim Hunt and state Rep. Karen Gottovi, who painted storm drains on the Cape Fear River waterfront in Wilmington. Throughout the coastal watershed, the project has had the winning combination of a strong educational message and the support of cities and volunteer groups. More than 35 cities and towns, plus the Cherry Point Marine Corps Air Station, have agreed to work with volunteers to stencil storm drains and catch basins. The stencils are tailor-made for drainage basins that flow to the Cape Fear River, Albemarle Sound and Pamlico Sound. Cities outside these basins will use generic sound and ocean stencils.

Volunteer groups have collaborated with city officials to map out the streets that they will paint, and they've agreed to follow strict safety guidelines. They have also agreed to pick up litter near the storm drains and record their finds on data cards, which will be returned to the Center for Marine Conservation and filed in a national data base.

In addition to local support, the project has been backed by Year of the Coast, N.C. Division of Coastal Management, N.C. Sea Grant, U.S. Fish and Wildlife Service, N.C. Cooperative Extension Service, N.C. Department of Environment, Health and Natural Resources (Divisions of Water Resources and Environmental Management), N.C. Big Sweep and the N.C. Coastal Federation.

Stenciling organizers hope to extend the storm drain project farther inland next year. For information about the project, contact Doll at 919/515-5287.

Scott D. Taylor

A great horned owl surveys his home at the Outer Banks Wildlife Shelter in Morehead City.

The Care of the Wild

By Carla B. Burgess

The Virginia rail opens its slender beak reluctantly, and a volunteer inserts a feeding tube. Her voice respectfully lowered, Cheryl Baptist looks on.

"You never get up close to these guys," she says of this marsh bird, which is very secretive in the wild. "This one was in the line of someone spraying for mosquitoes." Flushed from its marsh hideaway, the stunned and intoxicated bird then flew into a moving car.

Here in the intensive care room of the Outer Banks Wildlife Shelter (OWLS) in Morehead City, the rail was treated for a head injury and given an antidote to combat the poison. The swelling subsided and the bird's circulation improved, says Baptist, but it has "eye problems" and still won't eat on its own.

Outside the clean, white walls of this cinderblock building, cars and trucks whiz by on U.S. 70 toward Bogue Banks. An angler in a nearby estuary cuts and abandons a piece of tangled fishing line. A local gardener sprays her rose bushes for bugs. A bored child takes potshots at a hawk circling overhead.

And the casualties pour into OWLS, where Baptist — the only paid staffer at this privately funded nonprofit shelter — and some 40 volunteers try to repair the damage caused by humans. Through donations, the shelter treated 200 animals in its first year of operation in 1988. The annual patient load has ballooned to 2,000 animals. They see wildlife injured on the highway, birds that have swallowed poisoned insects, owls and hawks wounded by gunshots and pelicans with fishhooks lodged in their throats.

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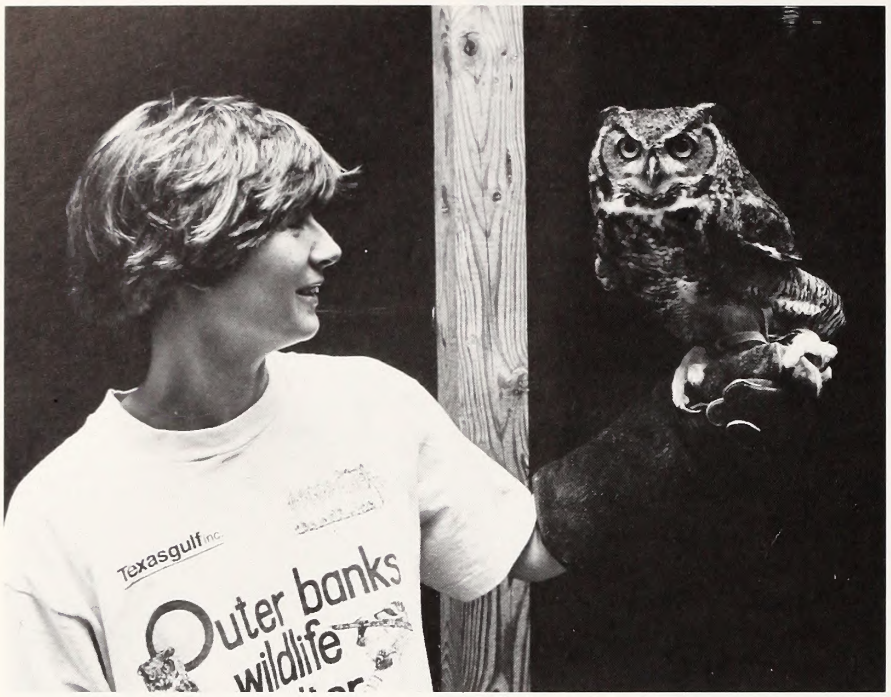
Scott D. Taylor



Morehead City rehabilitator Cheryl Baptist with a great horned owl.

This is not to say that wild animals don't meet their share of natural deaths from disease, predation and the elements. But as humans and wildlife compete for space, and people prevail, "wildlife rehabilitation" is becoming a household word. So much so that most states require people working in the field to obtain a license. In North Carolina, more than 500 permits were issued to people who doctor the state's wild animals. Rehabilitation of migratory birds and protected species requires an additional federal license through the U.S. Fish and Wildlife Service.

For rehabilitators to obtain a North Carolina permit, the state "only requires that they can exhibit some evidence of a background or training with animals," says Randall Wilson of the N.C. Wildlife Resources Commission, the licensing agency. Background on a farm, training with another rehabilitator or formal veterinary education are a few examples of experience that might qualify a candidate for a license, Wilson says.

But few rehabilitators are veterinarians. Most learn by trial and error. Yet rehabilitators almost always have a relationship with a veterinarian, who can provide medicine and anesthesia and perform surgery. In rehabilitation, the services of the vet and the caregiver are equally important.

"There's a complement there," says John Cely, wildlife biologist with the S.C. Department of Natural Resources, which licenses rehabilitators in our sister state. "The veterinarian can set bones and do some of the highly technical stuff. But some of the rehabilitators have the patience, experience and knowledge to get birds and other animals back into the wild. You can't just go out and throw them up in the air when you get out of the vet's office."

At OWLS, wildlife rehabilitation means treating the animals and preparing them for eventual release back into the wild, the ultimate goal. The shelter is not a petting zoo.

"A lot of people have misconceptions about wildlife rehabilitators," says Baptist. "The most important thing about the whole rehabilitation profession here is that people know we're not bunny huggers. We're not making pets out of these guys. We limit our contact with them as much as possible because we don't want them to get used to humans. We want them back out in the wild."

For some rehabilitators, the care and treatment of sick wildlife is a conservation technique. Still others see their participation as an obligatory hand to endangered or threatened species. And for many, it's purely a humane response to a suffering animal.

Rehabilitators as an entity are amorphous, as variegated as a sparrow hawk's plumage. They are conservative and liberal, vegetarians and meat-eaters, scientists and homemakers. And the anatomy of the wildlife infirmary has many forms. From the way station for ailing sea turtles and harbor seals outside a North Carolina public aquarium to the makeshift avian nursery in the kitchen of a Wilmington home, wildlife receive care ranging from a first aid pit stop to extended convalescence.

Olivia Burrus sprinkles a few soft-shelled crabs into a 500-gallon tank. An endangered Kemp's ridley sea turtle bobbing on the surface snaps a crustacean in its jaws as the others sink to the bottom.

A crack at the edge of the turtle's shell — probably a propeller wound — has been sealed with marine epoxy. Missing scales reveal gray, sunbleached patches on its back. An old gash glistens behind its neck. But the biggest problem, explains Burrus, is the confounding buoyancy that keeps the creature from the crawling crabs below.

Working with a Manteo veterinarian who assists with treatment, Burrus, the aquarist at the N.C. Aquarium in Manteo, speculates that bacteria in its intestines are producing gasses that keep the animal afloat. Or there's a leak in the carapace. Or maybe the sea turtle was caught in a shrimp net.

"When they're caught in a trawl, one of their lungs will blow out," she says. "There'll be air in the body until it repairs itself."

That afternoon, Burrus and a volunteer wipe the animal's shell with a sponge soaked in antibacterial solution. Later, the turtle will get another dose of

an antibiotic. After a week of recuperation, the turtle is taken to Oregon Inlet. Tagged and released near a shallow area thick with seaweed and crustaceans, the turtle is on its own.

"Sometimes I wonder about calling it rehabilitation," says Frank Hudgins, the aquarium's curator of husbandry. "When you really look at it, rehabilitation may require months."

But the aquarium can hold only three animals in its three-tank impoundment, which was built with state and federal grant money. And when there's a harbor seal or sandbar shark waiting in the wings, some patients must be discharged early.

Statewide, marine mammals in distress are assisted by the Marine Mammal Stranding Network, a mostly volunteer team of veterinarians, biologists and other specialists dedicated to assisting these protected animals. The state and federal governments provide some money to administer first aid. Unfortunately, much of the team's work consists of necropsies or examinations to determine why a dead animal washed ashore. Some die of disease or old age. But many bear the scars of human interference — gunshot wounds, plastic entanglement and strangulation, and gill net lacerations, to name a few.

The remainder of the network's job involves stabilizing injured animals and transporting them to a qualified facility. Easter Seal, a harbor seal that washed up on Long Beach in the spring of 1993, was stabilized by staff at the N.C. Aquarium at Ft. Fisher and two Southport rehabilitators. It was then transported to the veterinary school at N.C. State University. Wounded by a gunshot, the seal had several other problems, including severe kidney disease and cataracts. It died under anesthesia during eye surgery.

Happy endings are the exception rather than the rule. But good will compels people to keep trying.

"There's a very close correlation between coastal development and rehabilitation," says Cely, adding that interest in rehabilitation has surged in the past five to seven years. "We've started seeing more wildlife hit by cars, flying into windows and power lines, trees chopped down."

Scott D. Taylor

Pender County rehabilitator Victoria Meshaw Hucks displays her educational birds of prey, red and gray phase screech owls.

Subsequently, people are waking to the wild web of nature.

"People are becoming more concerned about wildlife," says Stephanie Goetzinger, who founded OWLS. "Instead of chopping down a tree with a nest of woodpeckers in it, some people are saying, 'Well, how long will it take them to grow up? Maybe we'll wait and take it down.'"

Beyond nurturing a wounded or orphaned animal, rehabilitators foster public awareness. Their greatest value, says Cely, is educational. As they struggle to repair the havoc wreaked on nature by humans, rehabilitators hold up our folly to public scrutiny.

Many rehabilitators keep a few unreleasable animals to encourage appreciation for wild species. OWLS offers programs on marine entanglement and puppet shows for young children.

Also, the experience gained by rehabilitators can broaden the scope of knowledge about the care of protected species.

"Most of the species that come through the program are common — squirrels or blue jays," says Cely. "But some of the groups do hawks and owls. That gives them experience to handle endangered species that come through like peregrine falcons and eagles."

When a severe storm hit the South Carolina coast in spring of 1993, a dozen bald eagle chicks were blown out of their nests, says Cely. A raptor center in Charleston was instrumental in rearing and releasing the national treasures.

But Cely is wary of the criticisms that rehabilitators don't appreciably help wildlife populations as a whole. He is also sensitive to complaints that wildlife biologists are apathetic to the plight of individual animals.

"Just about all rehabilitators are volunteers. They do it because they want to and put an awful lot of time in it. We think it's a humane service, and these people are certainly very dedicated," he says. "But without a similar effort to protect habitat, it's not going to do any good. A rehabilitated red-tailed hawk needs a minimum of 200 or 300 acres of habitat to survive. If we don't focus our energies on that kind of protection, rehabilitation is just going to be a symptom of a greater problem."

Continued

Wilmington resident Stephanie Pflieger has a different outlook. Describing herself as a staunch Republican with a "conservative outlook on the environment," Pflieger began rehabilitating eight years ago in Norfolk, Va., when her husband was stationed in the Navy.

"He was out to sea all the time, and the kids were little," she says. "They kept bringing me these birds, saying, 'Look at this bird, Mom. We have to save it.' It started out with a robin."

She figures she's rescued about 1,000 birds by now.

"I've actually been working with animals since I was a kid; I think you'll find that to be true of most rehabbers," says Pflieger, holding a green heron in a towel in her lap. "We've all got a little bit of Elly May Clampett in us."

The heron, which has a splayed knee joint, gulps down a few cigar minnows from Wal-Mart. Tomorrow, Pflieger will see if her veterinarian can fix the malformed leg.

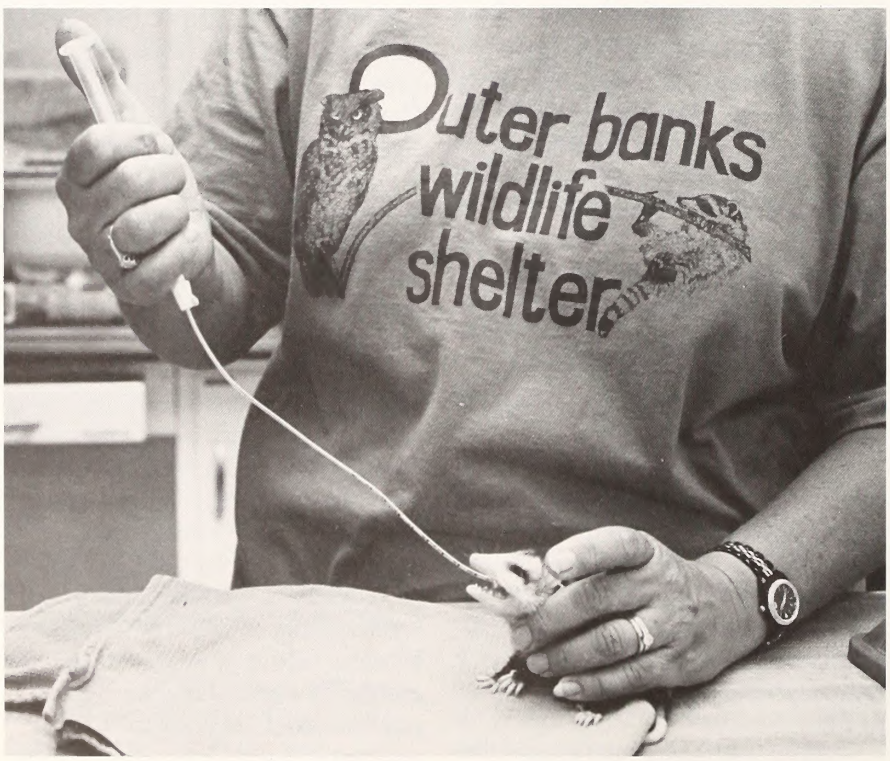
"Get me a grackle please," she calls to her son, who promptly brings a black bird to the kitchen table. "Open up your beak, you," she says, inserting a piece of moistened cat food in the boat-tailed grackle's beak.

On the tabletop, a dish of meal worms, a few mole crabs gathered from the beach and a box of hand-feeding formula keep company with her coffee cup.

Pflieger has a full house today: 31 birds, her specialty, and a rabbit. The flowered placemats on her dining room table are obscured by pet carriers. Boxes and carriers line the floor. The inhabitants include four baby clapper rails or "marsh hens," a mockingbird, willets and a few doves. Closest to her is an orphaned swallow, only a few days old, which sits on a heating pad inside a cardboard box on the floor.

Pflieger believes that human habitats and livelihoods will always come first.

"Yet I believe that we have no right to abuse these animals," she says. Her obligation to an injured animal, she says, begins when God cast her eyes upon it. And if it's unreleasable, but can eat on its own and breed, she'll care for it until its dying day.



Scott D. Taylor

A shelter volunteer tube feeds an orphan opossum.

Through the sliding glass door, she keeps an eye on one of her permanent patients that's on a backyard pass. Buster, a seagull with a broken wing, is eyeing the swimming pool. Before the pool was chlorinated this spring, it temporarily housed a loon whose leg had been gashed by a bluefish. The bird, which arrived emaciated and suffering from a severely infected wound, made a stunning recovery that surprised even Pflieger.

"To me there's no more gratifying and rewarding feeling in the world than to take a bird or animal that you've nurtured and taken care of and worried about and see it develop and then release it," she says.

At twilight in Watha, Victoria Meshaw Hucks wades through thigh-high grass in back of her black-shuttered cottage. In a clear plastic bag she carries a Neapolitan assortment of dead mice to her charges in three backyard pens — two barred owls, two red-tailed hawks and a great horned owl.

She puts on thick suede gloves and enters two owl pens. A hard afternoon rain has dissolved into a drizzle, and the wet birds look finicky as she doles out a handful of rodents on each perch.

"When I first got into rehabbing, I had to get someone else to kill my mice for me," she says, adding she's accustomed to it now. "It's all part of the circle."

The barred owls pop their beaks. The great horned owl turns its head sharply, fixing catlike eyes on the new visitor.

"Their eyes are so large in their heads; they don't have any muscles there. That's why they have to turn their heads like that," she explains. "They can turn their heads 340 degrees."

Hucks is in awe of great-horned owls, often called tigers of the night. "They have really strong talons."

She points to the big owl's tail. "Their feathers on the end are tattered so they don't make any sound when they fly," she says. "That helps with their night hunting.

"And their hearing is excellent," she says. "It's said they can hear the heartbeat of a mouse under a foot of snow."

She moves into a spacious covered chainlink pen, where two soggy hawks await dinner. "A man donated this kennel after I raised a nest of Carolina wrens he brought me," she says, moving toward a permanent red-tailed resident she calls Ranger. "In a cage, they look pretty benign; but if you get up on them, they can be very formidable."

She raises two gloved forearms toward Ranger in what looks like a martial arts stance. The hawk leans its shoulders back and raises its claws.

"They'll put their feet up to defend themselves before anything else," she says, sparring with the animal.

Wounded by a bullet, the desperate, emaciated bird was found chasing kittens on someone's porch. But when the hawk first arrived, it was too stressed to eat. Concerned, Hucks cupped a handful of chicken livers beneath the bird's beak, and it grabbed her wrist with its talon.

"That taught me never to hand anything to a hawk unless you have gloves on," she says.

A free-lance writer and wildlife educator, Hucks was mentored by an experienced Wilmington rehabilitator and consults regularly with the Charlotte Raptor Center. After a few years of rehabilitating, she adopted raptors as her specialty. Though she's bottle-raised beavers, rabbits and squirrels, she's known around this small Pender County community as "the owl lady."

"The first bird of prey that was ever brought to me was a barred owl," she says. "I just couldn't stop looking at it. I'm not a New Age type, but there was a connection there. I thought this is it. This is what I want to do. My grandmother had always loved owls."

Inside the house Hucks shares with her three children, four orphaned screech owls have begun a soft trill in their cages inside a small indoor porch. In a corner cage, red phase and gray phase screech owls look skeptical. Hucks uses these two — both with permanent injuries — in her educational programs.

She tosses a few mice into both cages. The orphans patiently tear into the fur with their talons and stuff pieces into their mouths. A glass cage of lizards on the floor beside them piques their interest in live prey. The owls stab at the paper lining in their cage, making confetti to bat and attack. They're almost ready for the wild.

Cartoon alligator lifeguards with pink and green beachballs frolic on a plastic swimming pool. In its shallow depths, four real-life raccoons splash through the water and climb up the front of their cage, peering out beyond the orderly maze of pens at OWLS.

There's a large concrete pool for pelicans, gulls and terns and cages of all sizes and shapes for raptors, reptiles and rabbits.

"We take in all species of wild animals," says Baptist, adding that marauding raccoons receive the same tender care as a pileated woodpecker. "All of them, to me, are special."

Inside the nursery, Maureen, a shelter volunteer, reaches into a makeshift marsupial pouch inside a dry aquarium. From an athletic sock wrapped around a piece of PVC pipe, she extracts a baby opossum. Maureen begins to "gavage" or tube feed the shy patient. A visiting photographer snaps a flash picture; the opossum winces. An onlooker muses whether this will train the animal to avoid the headlights of a car, an enemy that the opossum, if released, will most surely face.

To some people, including many biologists, this is too much ado for a so-called "trash" species with exploding populations. Most rehabilitators don't discriminate. But as volunteers see escalating numbers of sick wildlife — from the abundant to the rare — the philosophical question of what level of resources to devote to what species becomes evermore persistent.

The N.C. Aquarium at Ft. Fisher gets more than 100 calls a year from people who have found a seagull or other shorebird with a broken wing.

"It's not that we don't want to assist with birds and whatnot, but it's just too overwhelming," says Paul Barrington, curator of animal husbandry and a member of the Marine Mammal Stranding Network. "Animals

Continued

Scott D Taylor

Feeding time for baby chimney swifts at the shelter.

that can be easily rehabilitated — such as removing a plastic beer can ring wrapped around its neck — we'll do. But birds with broken wings are, more cases than not, terminal, and a lot of work has to be done."

The best the aquarium can do with a common species is refer the caller to a local rehabilitator and hope for the best.

"You're using all this time and resources to extend the life of some of these animals when all that money and energy could be more focused and directed toward a species of animal that desperately needs help," he says. "A possum is no more important or less important than a blue whale, but at least numbers-wise, you've got to, in my opinion, deal with the animals whose numbers are really down. I try to treat every animal as a living entity. But there are hard decisions that have to be made."

The task of rehabilitation often seems a sympathetic response performed in a vacuum.

"One of the important things that all wildlife rehabilitators have to be concerned about is the impact that their efforts will have on the free-living wild populations as well as the individual animals," says Michael Stoskopf, professor of wildlife and aquatic medicine at N.C. State University College of Veterinary Medicine. "Overall, I'm very supportive of (rehabilitation) in that I believe it gives people an opportunity to learn about wildlife."

But he stresses that rehabilitators need to be wary of the risks of reintroducing diseases into wild populations, including ones contracted when wildlife are exposed to domestic animals and humans. They also need to know where to release an animal to increase its chances of survival but without creating an imbalance in the predator-prey dynamics.

"We even have to be concerned about the impact that rehabilitation efforts might have on the accuracy or our scientific surveying efforts," says Stoskopf.

First and foremost, the rehabilitator must honor the best interest of the patient.

"There is tremendous value in the effort," he says. "The people that do this get a great deal out of it, mostly personal satisfaction. What the animals get out of it depends on the skills and abilities of the individual rehabilitator."

Serious rehabilitators, says Stoskopf, will involve themselves with mentor organizations such as the National Wildlife Rehabilitation Association or the International Wildlife Rehabilitation Association.

"There's room for many different individuals in the area of wildlife rehabilitation with different backgrounds and different interests," he says. "But it takes more than just desire."

Some states require rehabilitators to pass courses before they begin practice. North Carolina is not one of them.

"It's too easy in North Carolina to get a permit to rehabilitate," Hucks says. "Nobody comes out and checks your animals. I would like to see more people checking facilities, making sure people's permits are up to date, making sure that the birds they saw last month are still there, and if not, where are they."

For now, the best way for rehabilitators to stay on their toes is through networking. Rehabilitators have amassed a body of knowledge about diet, rehydration, parasites and diseases.

"If I come across something that I don't understand, I read about it. And if that doesn't fix the problem or it's beyond the scope of my understanding, then I'll call my vet or I'll call Joan (her mentor)," says Hucks. "You lose a lot of animals when you start. I think new rehabbers want to save everything. I've gotten a lot better about putting things down."

Some rehabilitators euthanize any animals that can't be returned to the wild. Others will give permanent care to crippled creatures. Hucks hopes one day to have a bonded pair of unreleasable raptors that can be foster parents to orphaned birds.

"I put a lot of stuff down, a lot more than I keep," says Hucks. "But once in a while when you're working with animals, just like with kids, you find one that's your favorite that you try to keep or place."

And once in a while comes the thrill of watching a red-tailed hawk — like one she raised from an awkward nestling — soar.

"He stayed around hunting," she says. "I would see him get snakes and rats, and eventually three more hawks came through here on migration. They were screaming and fighting behind the house, and he exhibited normal hawk behavior."

She's unsure whether the bird followed the others or embarked on a solitary journey. But the next day, he was gone.

"I have no doubt that my hawk did really well," she says.

Lundie Spence

A Kemp's ridley sea turtle gets a betadine sponge bath at the N.C. Aquarium in Manteo.

Knowing When to Help

The first rule of CPR is to make sure that the person you're giving it to needs it. Someone who appears unconscious is not necessarily in cardiac distress. It is also true that a lone fledgling bird hopping around your yard does not an orphan make.

Good intentions often go awry when humans try to "help" wildlife that are only doing what comes naturally.

The aquarist at the N.C. Aquarium in Manteo tells of a well-meaning man who spied a harbor seal napping on one of the state's northern beaches.

"He threw this seal in the toolbox in back of his truck and brought it here, thinking he was doing the animal a favor," says Olivia Burrus. "The only thing that was wrong with the seal is it had hauled out to rest a couple of days. We released him, and fortunately he was fine."

An orphaned opossum at OWLS.

A woman recently called 911 when she spotted a whale about 100 feet off the beach that she thought "couldn't breathe and was in distress," Burrus recalls. "But the whale was just up on the (sand)bar, rolling around, playing and having a good time, and she called 911."

Victoria Meshaw Hucks' red-tailed hawk, Ranger.

And though people are becoming more educated about respecting turtle nesting sites, it didn't stop a vacationing couple recently from transporting four "orphaned" sea turtles from a North Carolina beach to their Ohio bathtub, Burrus says.

"People's intentions are good, but they just don't know," says Burrus.

We also don't know how to keep our hands off baby birds. Ninety percent of the nestlings being raised by volunteers at the Outer Banks Wildlife Shelter in Morehead City shouldn't be there.

"There's a big misconception that the public in general has about wild animals, and it's that they can't raise their babies or they abandon their own babies," says shelter staffer Cheryl Baptist. Well-meaning folks bring in scads of nestlings that were probably faring perfectly well in their outdoor home. "We do a good job here, but the parent can teach them things that we can't teach them, like to be afraid of people."

Baby screech owls get care in Watha.

If you see a young bird that appears alone, hide from view and observe the animal. More often than not, you'll see its mother or father — which has probably been watching from a careful distance — return.

"Birds are called fledglings when they first start to fly. They don't fall out of the nest; they jump out of the nest," says Baptist. "The parent will continue to come down and feed them for quite awhile after they're out of the nest."

If the bird is in the line of pedestrian or automobile traffic, move it out of the way or place it on a tree branch close by. Contrary to myth, the parent will not reject a bird because it has been touched by a human. If a bird has leaped from a nest prematurely, return it to the nest if it is within reach.

"A lot of times you can take a baby bird and put it in a margarine tub strapped to the side of a tree, and the mother will come and feed it," says Victoria Meshaw Hucks, a Pender County wildlife rehabilitator. "True abandonment is more a fallacy than anything else."

If an animal isn't raised properly, it may be forever handicapped by a dependence on people. Some young mammals and birds — particularly deer, owls, crows and blue jays — may "imprint" easily on their human caretakers.

"Whatever they focus on whenever they start to focus — which is between two to six weeks of life — they think that's their parent and that's what they are," says Baptist. "It can never be reversed. It doesn't sound harmful ... but if you get a great horned owl who's imprinted, he thinks he's a person. And

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All photos by Scott D. Taylor

when he gets ready to mate, he's going to go to a person to mate. That can be very dangerous for that person and for him."

If you encounter an animal that is truly injured or orphaned and want to help, the appropriate response varies by species and situation. Most importantly, remember that a wounded wild animal is under extreme stress and may attack out of fear when handled.

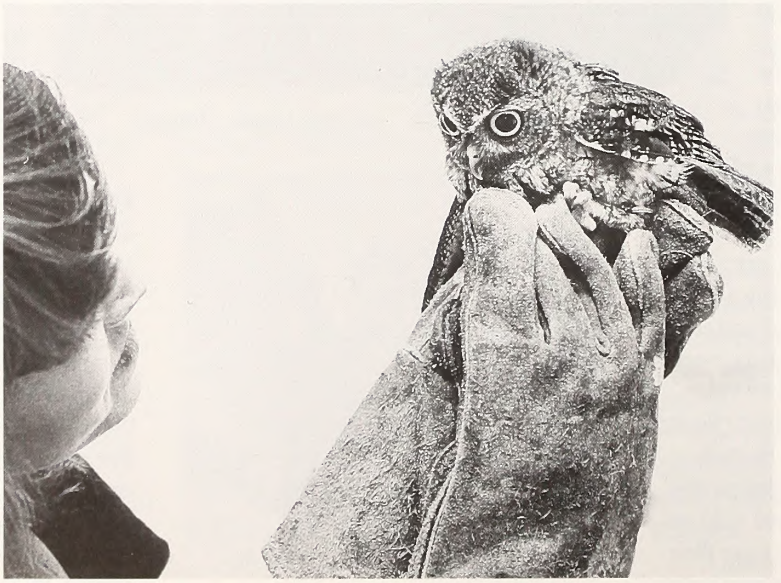
"The stress for those animals of just being close to us is phenomenal," says Stephanie Goetzinger, founder of the Outer Banks Wildlife Shelter. "We've had people bring an animal in and say, 'We held it all the way here, and it's so tame.' It's not tame; it's in shock."

Wounded sea turtles should be reported to the N.C. Wildlife Resources sea turtle coordinator or the nearest state aquarium. To report a dead or stranded seal, dolphin or whale, call the Marine Mammal Stranding Network. Do not approach or handle any large marine animals you find on the beach. It is unsafe, not to mention illegal.

On land, never touch a wounded animal with bare hands. If it's necessary to house it temporarily, keep it in a quiet area away from peering eyes and poking fingers. It is illegal to keep a wild animal for more than 24 hours without a proper permit.

A juvenile raccoon awaits release.

A squirrel hangs out behind a Morehead City shelter.



Hucks with a screech owl.

"If you don't know what you're doing, the best thing you can do is find somebody who does," says Baptist. "If somebody's had a baby bird for a week and all they've fed it is bread or water, it's not going to make it."

Your local veterinarian or law enforcement officers may be able to provide you with the name of a rehabilitator nearby. Also, the Wildlife Resources Commission office in Raleigh keeps a data base of the state's licensed rehabilitators and will refer you to one in your area. To find a specialist with birds of prey, try the Carolina Raptor Center.

WHO TO CALL:

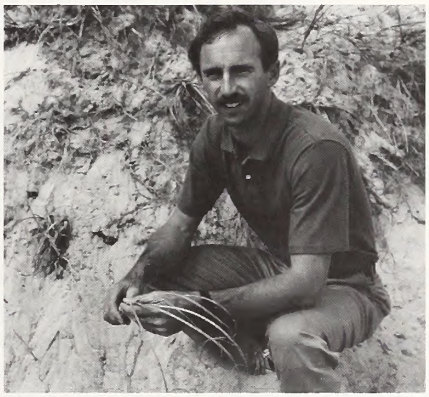
- Carolina Raptor Center, Charlotte: 704/875-6521.
- Outer Banks Wildlife Shelter, Morehead City: 919/240-1200.
- N.C. Wildlife Resources Commission office, Raleigh: 919/733-7123.
- N.C. Wildlife Resources Commission sea turtle coordinator: 919/726-7157.
- Marine Mammal Stranding Network, Vicky Thayer, National Marine Fisheries Service area representative: 919/240-0386 or 919/728-3595.
- N.C. Aquarium, Manteo: 919/473-3494.
- N.C. Aquarium, Pine Knoll Shores: 919/247-4004.
- N.C. Aquarium, Ft. Fisher: 910/458-8259.

Carla B. Burgess

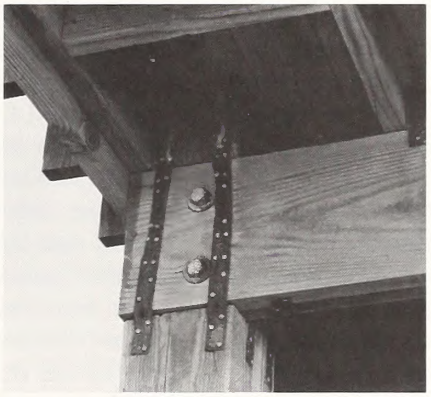
Rogers' Motto: Be Prepared

If you're going to look a hurricane in the eye, it's best to be prepared. That's what Sea Grant extension specialist Spencer Rogers has been telling coastal homeowners, building code councils from North Carolina to Texas, and federal insurance and emergency management officials.

For more than a decade, Rogers has preached the payoffs of hurricane-resistant construction. He's urged homeowners to build their beach houses high atop pilings sunk deep in the sand and fastened securely with corrosion-resistant hurricane clips and connectors. He's educated the construction industry and helped make the N.C. Building Code a model for other Southeastern states wanting to shore up their coastal construction standards against these monster storms.



Spencer Rogers



Hurricane-resistant construction

And his sermons have paid off. A comparison of post-storm damage and costs resulting from Hurricane Diana in North Carolina and Hurricane Alicia in Texas — storms of similar size — showed that Tar Heel coastal homeowners saved $80 million in repairs. The difference? North Carolina had tougher standards for coastal construction.

Rogers' construction lessons have other payoffs too. They can help homeowners save on their annual federal flood insurance premiums. Each year, homeowners who live in flood zones along the coast pay an average of $367 to the National Flood Insurance Program to insure their homes against high waters from hurricanes and other coastal storms.

But those homeowners who have heeded Rogers' advice and built piling-supported houses can get a 60 percent savings on their premium payments. For the average owner of a beach house, that can mean a savings of $220 a year.

New beach homes can be designed and built to ensure that savings are guaranteed, Rogers says. Over the 70-year lifetime of a house, a homeowner can save more than $15,000.

To spread the word about this possible windfall, Rogers has been talking to homeowners, builders and insurers. He's written fact sheets and talked to the media. Homeowners from Corolla to Brownsville, Texas, have gotten the message and pocketed the savings.

In another effort to save homeowners time and repair costs, Rogers worked with the LaQue Corrosion Center in Wrightsville Beach to study the corrosion rates of metal tie-down straps in the beachfront environment. He found that typical hurricane straps used in oceanfront and first-row homes corroded within five years and were ineffective in securing the connections between roofs, walls and foundations. To withstand corrosive forces, clips needed to be heavily galvanized with a zinc coating or made of stainless steel.

Based on Rogers' findings, the N.C. Building Code Council adopted regulations requiring builders to install corrosion-resistant connectors in new oceanfront construction. Again, the news of Rogers' work spread to other Southeastern states, particularly Texas, and homeowners began asking building suppliers for galvanized and stainless steel connectors.

In response to the growing demand, two national companies added stainless steel clips to their product lines. Other companies began offering clips with a heavier galvanized coating. Now, the market for corrosion-resistant clips is estimated at $250,000 annually. And homeowners who use them save untold millions in roof and foundation repairs in the aftermath of hurricanes.

Because of Rogers' efforts to extend information to the public about erosion and coastal construction, he was recently awarded a 1994 Outstanding Extension Service Award by N.C. State University. The awards are given to faculty and staff for superior performance in extending new information, practices or public service programs and in encouraging their adoption.

To receive some of Rogers' sage advice, send for one or all of the following publications.

• *Wooden Wind Anchors for Hurricane-Resistant Construction Near the Ocean*, UNC-SG-BP-84-3. 2 pages. Free.

• *Corrosion in Salt Air*, UNC-SG-BP-85-3. 4 pages. Free.

• *Saving Money in the Wake of Changing Flood Maps*, UNC-SG-BP-92-02. 2 pages. Free.

• *Saving Money on Flood Insurance for Coastal Property Owners*, UNC-SG-89-05. 12 pages. $1.

Send orders to N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Another Kind of Recycling

Composting is a home-grown, do-it-yourself recycling project.

This natural approach to reusing trash holds promise for the North Carolina seafood processing industry. Rather than landfilling seafood waste or dumping it onto agricultural fields, processors can safely and more efficiently dispose of their scraps in a way that yields a nutrient-rich soil supplement.

Eventually, the composted remains could be approved for use on lawns, gardens or farms.

Sea Grant agent Rich Novak is technical advisor to a research project at Mattamuskeet Seafood in Hyde County to compost crab scraps. Wood chips for the compost pile are supplied by Weyerhaeuser Inc.'s Plymouth plant; two dump trucks full of crab wastes are added daily from the seafood house.

After composting four to six months, the nutrient-rich product is usually ready. Mattamuskeet Seafood farms it out to Weyerhaeuser as a fertilizer for its Beaufort County tree nursery. The chitin in the crab shells is thought to be a deterrent to plant-eating nematodes.

Experimentation will continue this year using different ratios of wood chips to crab scraps and different intervals for turning the compost. Turning introduces air into the heap, which fuels the bacteria and the composting process. Even without turning, however, the temperatures inside the piles reach 140-160 F within a matter of days, and the compost "cooks," Novak says. Old compost material has also been used in lieu of wood chips when availability is low.

Meanwhile, the compost piles are being tested for fecal coliform, salmonella and heavy metals by scientists at East Carolina University and the N.C. Department of Agriculture. These tests will determine whether the compost can be approved by the state for use on gardens or crops. Weyerhaeuser has been allowed to use it in a cooperative research effort that does not involve food crops.

The Albemarle-Pamlico Estuarine Study has funded the project, which is permitted by the N.C. Division of Solid Waste. To learn more, contact Novak at 919/473-3937, Patty Buck at Mattamuskeet Seafood at 919/926-2431, or Pat Hooper at the N.C. Division of Soil and Water Conservation at 919/946-6481.

Life After Nets?

A fishing net in North Carolina has more lives than a fish-house cat. Commercial shrimp and flounder trawl nets are usually patched and repaired rather than abandoned. Older, large nets, such as those used in the menhaden industry, are often given to smaller-scale fishermen to trim down and reuse. Ultimately, a net may even find retirement as a soccer goal or baseball field backstop.

But the estimated quarter of a million crab pots discarded annually in North Carolina are less versatile and more likely to end up in the solid waste stream.

To explore the fate of old fishing gear and determine its recyclability, Sea Grant and the National Marine Fisheries Service are working with commercial fishermen in the Southeast.

One plan being discussed is a collection day for old nets and crab pots. Slated for late January or early February, the date will likely fall within the one-week period in which the N.C. Division of Marine Fisheries requires removal of all crab pots from the water. The N.C. Division of Waste Reduction has assigned a staff member to work with county solid waste management and coastal fishermen to develop this plan.

Meetings were held in coastal towns this summer to enlist the leadership and support of coastal fisheries groups.

Net recycling has been tested on the West Coast, where fishing activities are concentrated in large ports and ocean nets are replaced more often. This project will explore the issue from the perspective of the more scattered fisheries of the Carolinas and Georgia. Sea Grant specialists in South Carolina and Georgia are also participating.

The net and crab pot collection period will be Feb. 8-11, which is Wednesday through Saturday. Sixteen collection sites were identified in nine coastal counties.

To volunteer or get more information, contact Gerry Sutton, N.C. Division of Waste Reduction, 919/571-4100; Bob Hines, N.C. Sea Grant marine agent, 919/247-4007; or Wayne Wescott, N.C. Sea Grant regional specialist, 919/473-3937.

Charter Boats Troll for Trash

When sportfishermen trolled along the Gulf Stream off the coast of northeastern North Carolina in September, they ogled more than the large pelagic fish that feed along the drift line.

These anglers looked for debris that gathers — along with tuna, dolphin and other prized sportfish — where the warm sapphire waters of the Gulf Stream collide with coastal waters. Their observations will be counted and recorded in the first known project of its kind in the United States.

At the request of Sea Grant specialist Rich Novak in Manteo, at least 20 chartered fishing boat captains out of Oregon and Hatteras inlets volunteered to carry "data cards" on which they and their passengers recorded the cans, bottles, wood scraps and other debris observed floating in the "weed line." This interface of coastal and Gulf Stream waters is a favorite feeding spot for sportfish that seek out smaller fish hiding in the masses of floating seaweed.

"We've heard fishermen tell about the trash and oddities they've seen along the Gulf Stream," says Sea Grant marine education specialist Lundie Spence. "But we've never had a quantitative figure."

The tally cards, a modified version

The tally cards, a modified version of the ones used in national and international beach cleanups, were placed on participating boats for about four weeks.

"The weed line has always been a fascinating treasure trove of seaweed, fish, Portuguese man-of-wars, even coconuts," says Spence. "It will also bring up anything that's been floating for a while, like trash. The intent of this project is to establish a base of knowledge for what is found floating in the coastal waters and in the Gulf Stream."

N.C. Sea Grant will evaluate the information and forward copies of the data cards to the nonprofit Center for Marine Conservation, based in Washington, D.C. The center keeps a data base of the items collected during the annual international beach cleanups. But this information — debris observed offshore and in the Gulf Stream — is unique, says Kathy O'Hara, the director of the center's marine pollution prevention program.

Future in Summer Flounder Farming

The regulatory answer to declines in summer flounder stocks has been a size limit on those that didn't get away. Thirteen inches and more in inside waters, they're good for the cooler. Smaller, they go back into the water for a chance to spawn. Likewise for those smaller than 14 inches in the ocean.

But Sea Grant researchers are looking for another solution — farm raising new ocean stock.

The research project, funded by a grant through the National Marine Fisheries Service, aims to grow young 1-to-2-inch "fingerlings" that can be released into the ocean to enhance flounder stocks weakened by overfishing, pollution and habitat degradation. This restocking approach has been effective in Texas bays with red drum, says researcher Ron Hodson, associate director of N.C. Sea Grant.

Additionally, the project aims to grow summer flounder to maturity for the seafood market. "Flounder, in general, is one of the most popular fish worldwide," Hodson says. "Most inland people like it because it's mild, and it's popular along the coast as well."

Overseas, flounder is also a favorite for sashimi, a Japanese dish of thinly sliced raw fish.

The summer flounder will be raised in an aquaculture setting using technology funded by Sea Grant and developed by Hodson and Craig Sullivan, an associate professor of zoology at N.C. State University. In September, Sea Grant agents Bob Hines and Rich Novak began collecting the "broodstock" of parent flounders from coastal waters near Morehead City and Manteo.

The next step is to domesticate these fish, acclimating them to life in holding ponds and training them to eat fish feed, Hodson says. Over the course of a year, they will be prepared to spawn to assure a ready supply of larvae and fingerlings.

Hodson and Sullivan will draw on their seven years of experience researching the reproductive cycles of striped bass. The research team has worked to understand and gain control of the fish's cycles in hopes of spawning them more than once a year. Carefully timed hormonal injections cause the fish to spawn.

The logistics of the flounder project, however, will be more complicated than those of the striped bass research. The summer flounder, often called ocean flounder, prefer saline water from 25 to 28 parts per thousand. Typically, they come inshore to feed in the summer and return to the ocean in fall to prepare for a December or January spawn in water 60.8 F to 64.4 F.

The project will have to mimic the migrations of these fish from salty to brackish water and back again, Hodson says. The work will take place at the Pamlico Aquaculture Field Laboratory in Aurora and on the NCSU campus.

Eventually, the technology gained from this project can be applied to southern flounder, which prefer low-salinity water. They venture into the ocean only to spawn and then return inland. In fact, farm-raising southern flounder has great potential in North Carolina because these fish could possibly be grown in ponds using groundwater resources. Brackish water might be mined from deep coastal aquifers, making flounder farming possible inland, Hodson says.

Public Trust Debate

The N.C. Legislature will ultimately decide how much the state should charge private marinas to use public lands and waters for a profit.

The July/August issue of *Coastwatch* explored the controversial issue of requiring marinas to apply for easements — in this case, a land transfer recognizing a right to build docks on state-owned waters — and pay the associated fair market value.

At the time, the Department of Administration's State Property Office had recommended a 10-cent charge on every square foot of public land or water claimed exclusively by marinas. But marinas claimed that the fee would be too high and a burden to their businesses; environmentalists countered that it wasn't high enough to represent the market value.

The N.C. Council of State, which was in the position of accepting or rejecting the 10-cent fee, responded in August by sending the question directly to the Legislature for resolution.

In the interim, the state will grant marinas one-year easements with two one-year renewals. They will be charged administrative fees of $250 or 1 cent per square foot, whichever is greater.

The issue erupted in North Carolina in the wake of two recent court rulings that found the state wasn't following the letter of its own law.

The Department of Administration — charged with managing the state's submerged lands — has always exempted marinas and docks from a state law requiring for-profit, exclusive users of public trust areas to apply for an easement and pay fair market value. The rationale was that they had riparian rights to the water as owners of waterfront property.

The courts found, however, that riparian rights are not adequate to exempt marinas from the process. As a result, the state is requiring marinas to apply for easements.

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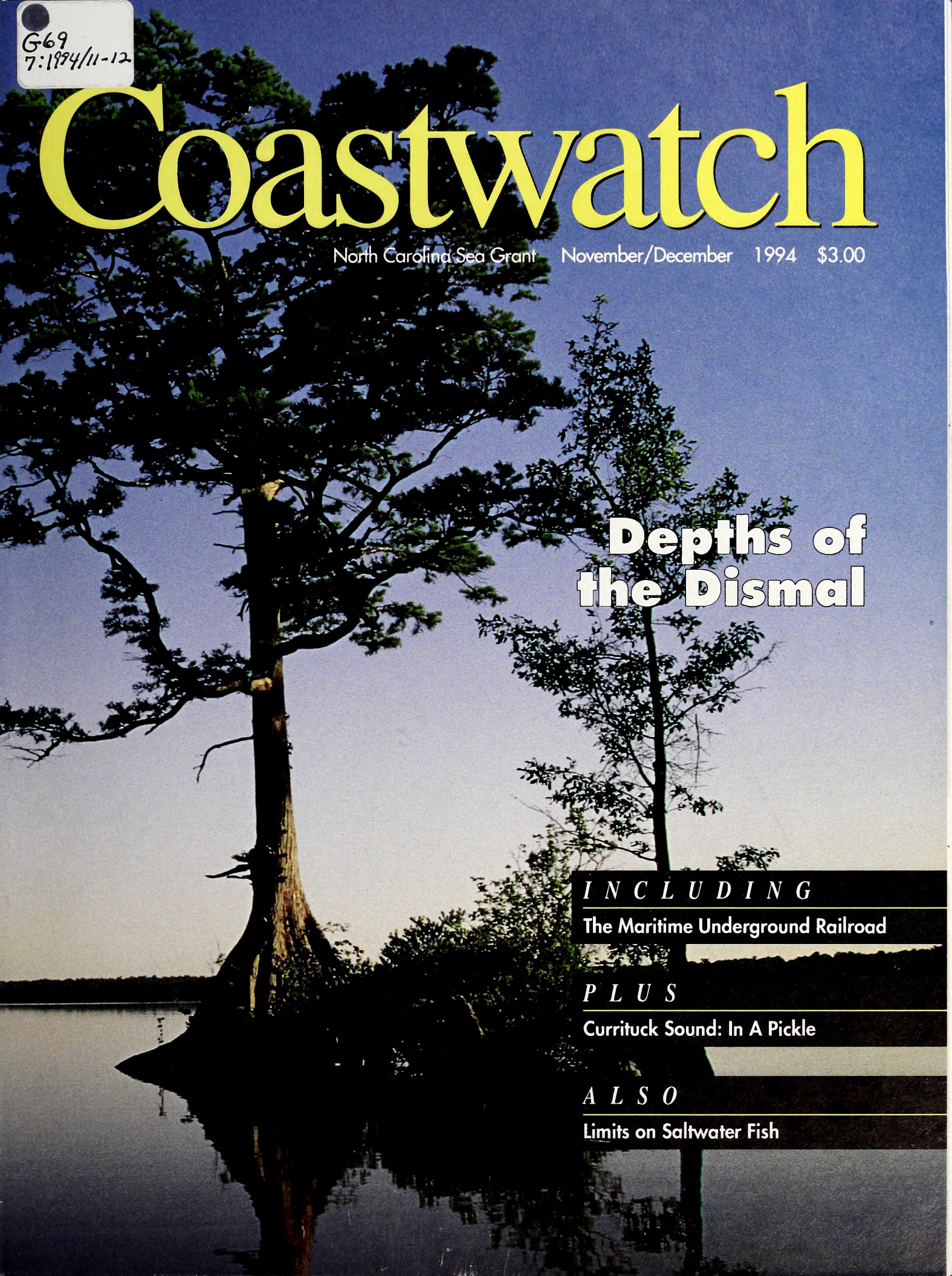

Depths of the Dismal

INCLUDING

The Maritime Underground Railroad

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Currituck Sound: In A Pickle

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The North Carolina Sea Grant College Program is a federal/state program that promotes the wise use of our coastal and marine resources through research, extension and education. It joined the National Sea Grant College Network in 1970 as an institutional program. Six years later, it was designated a Sea Grant College. Today, N.C. Sea Grant supports several research projects, a 12-member extension program and three communicators. B.J. Copeland is director. The program is funded by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration and the state through the University of North Carolina.

Coastwatch (ISSN 1068-784X) is published bimonthly, six times a year, for $12 by the North Carolina Sea Grant College Program, Box 8605, N.C. State University, Raleigh, NC 27695-8605. Telephone: 919/515-2454. Fax: 919/515-7095. E-mail: k_hart@ncsu.edu. Second-Class Postage paid at Raleigh, N.C.

POSTMASTER: Send address changes to *Coastwatch,* N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695-8605.

Front cover photo of Lake Drummond in the Great Dismal Swamp by George P. Johnson.

Inside front cover photo of boat docked on Currituck Sound by C.R. Edgerton.

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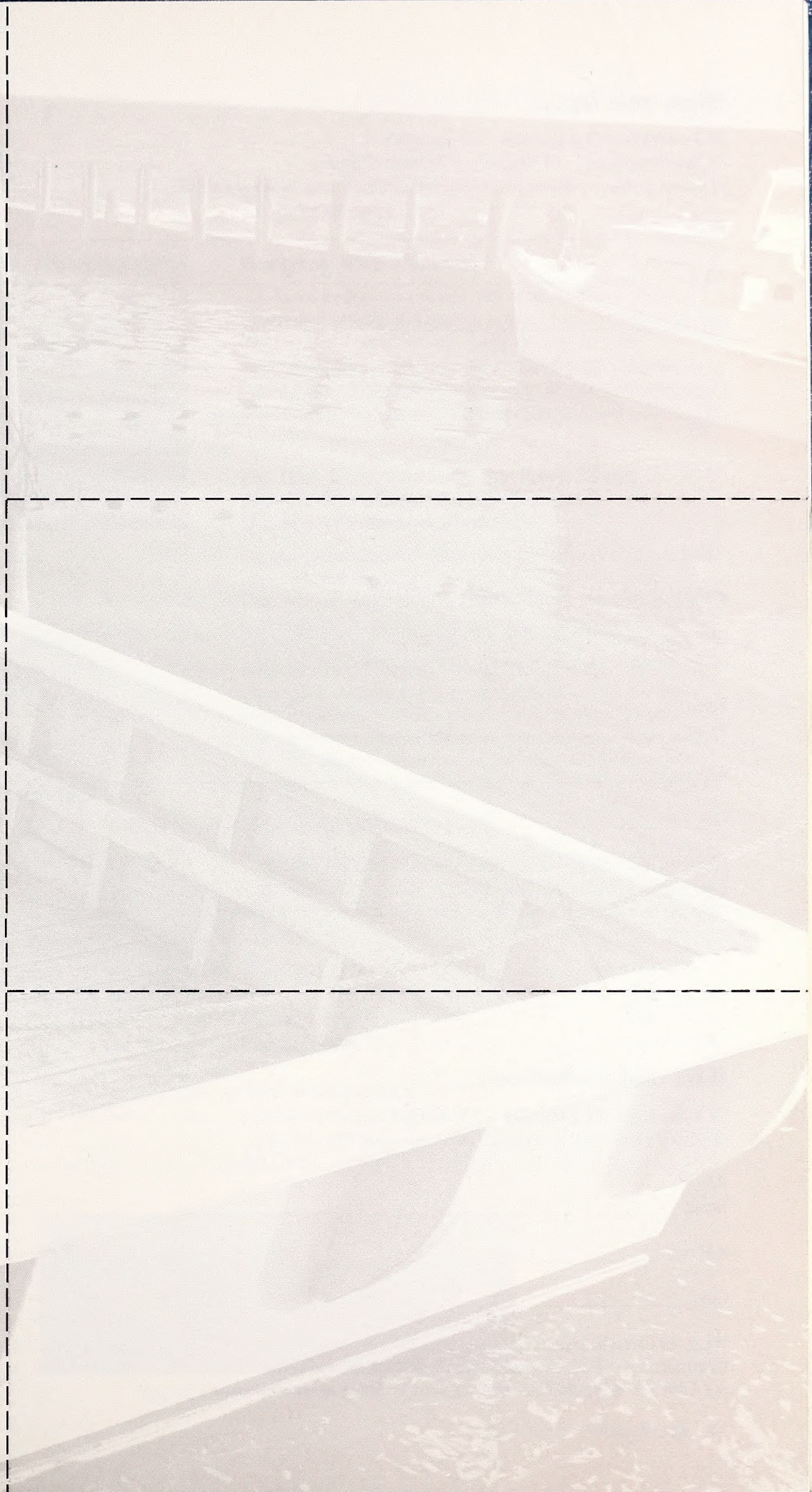

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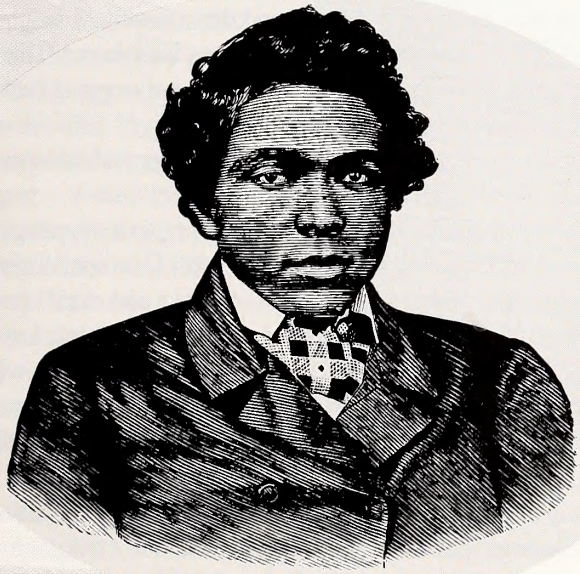
Forging the Dismal

Lured by ghost stories and tales of the strange, former *Coastwatch* writer C.R. Edgerton makes a foray with a buddy into the Great Dismal Swamp. Along the way, he meets adventurous hikers, seasoned swampers and long-time canal keeper Ray Jenkins. Meanwhile, he looks beyond the swamp's gloomy moniker to discover a natural wonderland of sights and sounds.

By the Compass or By Any Star: North Carolina's Maritime Underground Railroad

An untold chapter of North Carolina's history comes to light like a Polaroid photograph in the hands of historian David Cecelski. The author of *Along Freedom Road* takes *Coastwatch* readers down the tracks of the maritime Underground Railroad, an oceangoing route to freedom for an untold number of slaves in antebellum North Carolina. Cecelski reveals a layer of tidewater culture long concealed by popular images of magnificent and tranquil plantations. And he introduces the players who risked life and liberty to sustain this pathway to freedom — from black watermen and slave stevedores to reclusive swampers and sympathetic whites.



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Holiday Taste Treats

With the holiday season at hand, many cooks are looking for fresh ideas for hors d'oeuvres. Whether you're having a big party or a small gathering, let seafood be part of your menu.

Departments

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Forging the Dismal

by C.R. Edgerton

At 5:30 a.m., Johnnie's Diner is a blaze of orange.

A half-dozen hunters pour in from the cool fall drizzle and assemble in booths lining the walls. They want biscuits, eggs, grits, sausage.

Before the food arrives, they share a side order of tall tales.

Here on the North Carolina side of the Great Dismal Swamp, hunters in bright caps talk of how good the sport is, especially deer. They speak with reverence of successful hunts, good companions and favorite dogs.

One man is mad at his wife for not going by a friend's house the day before to pick up his prized hound.

"You guys hunting today?" he asks me and my traveling companion, George.

"No, just exploring."

The hunter grins.

"You ever done much hunting around Lake Drummond?" I ask.

"Yeah," he says. "Before they made it a park."

He's talking about the Great Dismal Swamp National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service as a last vestige of the once-great swamp. We tell him we're going to paddle the Feeder Ditch into Lake Drummond this morning.

Once before, bad weather had forced us back home. This time, we say with a certain amount of naive pride, we're going into Drummond regardless.

He grins again, turns to his breakfast partner and whispers something. They laugh under their breath. I feel uneasy.

I'd heard about the refuge, a 107,000-acre spot of spongy soil and tangled undergrowth straddling the North Carolina/Virginia line between Sunbury and Suffolk. Scores of books and stories have been written about the deep swamp's dark secrets, ghost stories, tales of hidden runaway slaves and sad stories of men who wandered in but not out.

Those tales have been seasoned with accounts of ferocious bears, screaming bobcats, diverse flora and a remoteness that makes the swamp a favorite getaway for hikers, campers, scientists and other exploring types such as George and me.

That's why the hunters' caustic laughs make me squirm. I ask George if he still wants to tackle the Great Dismal. "Yeah," he says.

The Great Dismal Swamp was formed thousands of years ago by one of several forces, depending on your scientific bent. Some say it's a remnant of an ancient sea; others point to the swamp's most prominent feature, Lake Drummond, and say it was formed after a great fire burned a depression in the swamp's peat-based soil.

Native Americans moved into the swamp more than 13,000 years ago. Archaeologists have found evidence of their villages, particularly on the northwestern boundaries. By the mid-1600s, Native Americans moved to more hospitable areas, and Europeans found little to interest them in the Great Dismal's foreboding depths.

In 1665, a small party of adventurers forged into the swamp. Only one returned: William Drummond, who later became a contro-

versial governor of North Carolina (controversial enough to be hanged for insurrection). Upon his return from the swamp, Drummond told of a huge lake in the center. It was subsequently named for him.

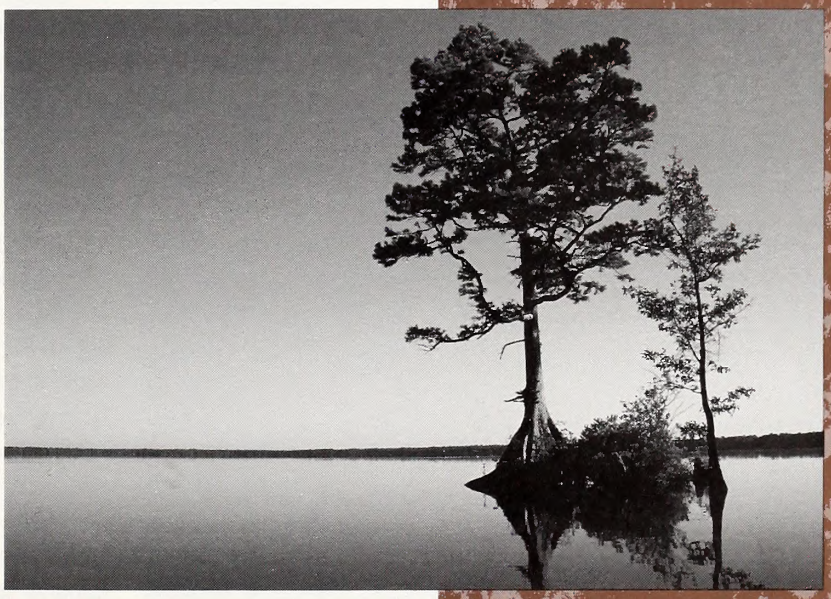
Other famous folk have made their marks in the Great Dismal. William Byrd II led a surveying crew into the swamp in 1728. While his crew withstood the rigors and dangers of the Great Dismal, Byrd, who loved comfort more than adventure, partied in Edenton, then a major North Carolina port.

But George Washington, in 1763, was perhaps the most famous man to muddy his boots in the Great Dismal Swamp. Washington not only was the first commander-in-chief and a well-respected man, but also an astute businessman. For him, the swamp was far from dismal.

Washington realized the value of the area's great stands of virgin Atlantic white cedar. He organized the Dismal Swamp Land Company after discovering that the center of the swamp was 18 feet higher in elevation than the edges. The company purchased 40,000 acres during the next two decades. Huge portions of the wilderness were drained and logged.

A 5-mile ditch, dug with slave labor on the west side of the swamp, leads into Lake Drummond and still bears the name of our first president. Some historians point to Washington Ditch as the first monument to bear his name.

George P. Johnson



Lake Drummond

Washington's success in the Dismal prompted a sort of swamp fever that resulted in most areas of the swamp being logged at least once. The scars of that 200-year clear-cutting spree can still be seen in the number of ditches and canals that crisscross the Dismal like stitches on a patchwork quilt. Drainage and deforestation drastically changed the swamp's sensitive hydrology, changing the face of the Great Dismal forever.

Roads built along the ditches — first used by mules pulling log barges and later by trucks spewing diesel fumes — blocked the swamp's natural flow, creating huge areas of stagnant water during rainy months. The swamp's greatest wonder, thousands of acres of Atlantic white cedar, was replaced by red maple and other species, particularly gum and poplar. The result of man's first invasion of the Dismal was a drastic decrease in the diversity of flora and fauna.

Successful logging led to agricultural development as farmers

Continued

learned how to drain chunks of the swamp to get at the rich eons-old soil that lay beneath the disappearing trees. That's why less than half of the original Dismal is still swampland. The remainder nourishes everything from tobacco to wheat. As the swamp retreated to the slice of the iron plow, so did the number of animals that inhabited the area.

In 1973, the Union Camp Company, the last major corporation to cut trees in the swamp, donated 49,100 acres of the Dismal to The Nature Conservancy. The U.S. Fish and Wildlife Service agreed to manage the land as a wildlife sanctuary and nature preserve. Union Camp's gift, added to land that the government had purchased in the swamp, created the 107,000-acre refuge.

George P. Johnson

Abandoned hunting lodge on Lake Drummond

I'd boned up on this wonderland by reading Bland Simpson's *The Great Dismal*, but I'd never seen the swamp from beyond the highway. George and I feel a tinge of excitement. What would we find in this mysterious patch of spongy earth?

We walk to the counter at Johnnie's to pay our tab. A sign at the cash register announces the owner's philosophy and is an omen of sorts to two strangers in the Great Dismal. "Today's Menu: Two Choices. Take it or leave it."

Drizzling rain greets us at Arbuckle Landing on the Virginia side of the swamp. As we canoe into the Great Dismal Swamp Canal, a flock of geese honks overhead, clipping low-lying clouds, heading east toward the ocean in a near-perfect chevron. Their racket drowns out traffic on U.S. 17, which parallels the canal. As we turn onto the Feeder Ditch a few minutes later, the geese return, making a turn toward Lake Drummond, a good three miles up the ditch.

The Feeder Ditch was dug in 1812 to provide water for the canal and to simplify travel to Lake Drummond. The 3-mile ditch is about 3 feet deep and shoots straight through the heart of the Great Dismal. It's the only direct route to the lake and to a campsite nearby that hosts about 10,000 visitors a year.

Overhead, a large blue heron lopes out of a high tree and heads up the canal. As we make our way into the swamp, the majestic bird flies a few hundred yards, alights in a tree and waits for us to catch up. It never allows us to paddle closer than 50 yards before taking off again.

Paddling the ditch is easy, smooth. In less than an hour and a half, we step out of the canoe and onto the Lake Drummond Campground, run by the U.S. Army Corps of Engineers. The drizzle has subsided, and things aren't as gloomy.

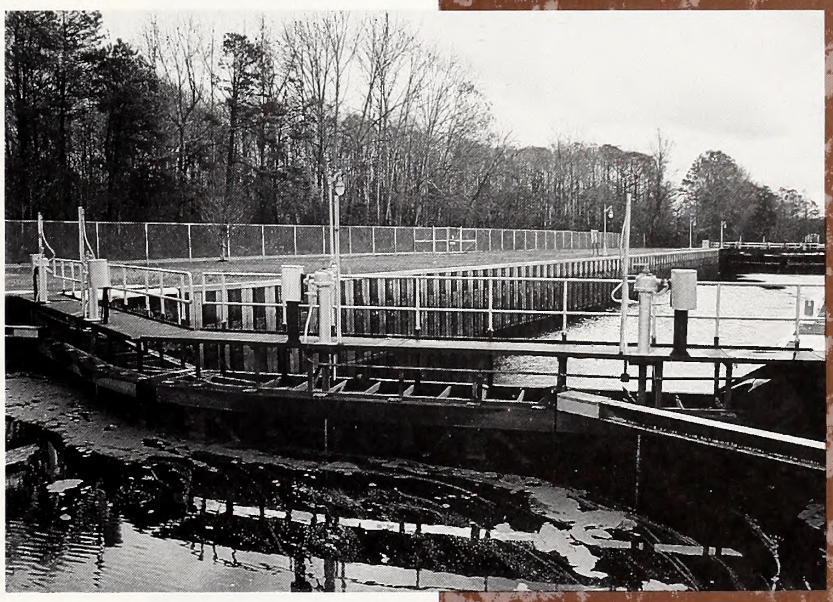
We meet a small group of hikers that had walked into the swamp a day earlier from a point near Suffolk, Va. Guided only by the experience of swamper Judy Kernell, the hikers have dodged greenbrier, soggy ground and vines as thick as soup cans.

Kernell has been leading hikers through the Great Dismal for 18 years by permission and with a special use permit. She explains that there are only a few trails marked through the swamp's rough terrain. (Visitors to the refuge must stay on designated trails.) But she knows them all, having blazed a few herself. She also knows the magnificent flora of the region and carefully points out to her hikers the variety of plant life that springs from the soggy soils.

Notable among the swamp's hundreds of plant species is the dwarf trillium, a rare plant found in its northwestern corner near Jericho Ditch. It blooms for two weeks in March.

Silky camellia, another rarely seen plant, can be found along the swamp's few hardwood ridges. And the log fern, one of the rarest of American ferns, is said by biologists to be more common in the Great Dismal Swamp than anywhere else in the world.

George P. Johnson



The Feeder Ditch

On a later trip into the swamp, I would hike the rutted road that parallels Washington Ditch on the western side of the swamp. It's an easy four-and-a-half-mile trek into the heart of the Dismal. It's the same trail once used by George Washington's mules as they pulled logging barges out of the swamp.

The Washington Ditch trail ends at Lake Drummond. During the late winter rainy season, hikers can see the area's amazing hydrology at work. The swamp soaks up water like a sponge, and then the huge hand of nature squeezes it out.

The water, colored tea brown by the thick layer of surface organic matter and tannic acid, slips gracefully, and sometimes forcefully, into the drainage ditches. From there it flows into Lake Drummond and out again into the Dismal Swamp Canal through the Feeder Ditch.

The Fish and Wildlife Service has successfully restored some of the swamp's natural hydrology by installing water control structures in some of the ditches. A hike down the Washington Ditch is the best way to see it work.

Back at the campground, the hikers are still relying on Kernell to blaze their early morning trail. By midmorning, they disappear into the thick undergrowth on the south side of the campground. Another two

Continued

days of hiking will bring them to their destination: the village of Sunbury on the swamp's southern edge.

"They're tougher than I am," says Ray Jenkins, whose job brings him out to the Lake Drummond campground five days a week.

Jenkins has been the primary keeper of the Great Dismal Swamp Canal for 18 years. It's his job to regulate the flow of water from Lake Drummond through the Feeder Ditch spillway and into the canal. The lake is the canal's main water supply, and it must be controlled so that the canal doesn't drain the lake, which is only 4 or 5 feet at its deepest.

The Great Dismal Swamp Canal, completed in 1805, is the nation's oldest artificial waterway. Its designers envisioned the canal as a major regional waterway, but over the years that dream withered.

Though important to the swamp's major logging industry, the canal never lived up to its original purpose. The failure can be seen in its major design flaw: canal owners relied on rain to fill the big ditch with enough water for safe passage. And there isn't always enough rainfall, especially in summer months, to keep water levels high enough for boat travel. The construction of the Feeder Ditch didn't help, for Lake Drummond's level is also determined by rainfall.

George P. Johnson

Judy Kernell (left) leads hikers.

The U.S. Army Corps of Engineers, which manages the canal today, runs into the same problem. Occasionally, the canal must be closed during hot, dry weather. During these dry spells, boaters must use the Dismal Swamp Canal's sister waterway, the Albemarle and Chesapeake Canal, a few miles east.

Still, the Great Dismal Swamp Canal — a link in the Intracoastal Waterway — is an important shortcut between Elizabeth City and Norfolk. It's also important to Jenkins, who owes his livelihood to the fickle brown water.

Around noon, Jenkins saunters off to the small, white frame dwelling that houses his office. It's simply furnished with a desk and chair, a couch for visitors and a telephone. A handcrank that opens the gates on the Feeder Ditch dam hangs loosely on a stairwell by the door.

Jenkins takes a seat and chats with us about the pleasures and pitfalls of working in one of the most remote natural areas on the Eastern Seaboard. A couple of older hunters in camouflaged jumpsuits and jackets meander in. Their shotguns are conspicuously absent.

The men seem more interested in Jenkins' hospitality than in hunting. They wander to a back room, where a kettle of sumptuous stew simmers on a small gas range. Dipping a ladle into the pot, they retrieve a stew of navy beans and Polish sausage. They've done this before.

"Was that you that fired those three shots this morning?" Jenkins asks one of the hunters, whose name is Dick.

"Not me," Dick says. "Besides, I've only got two shots anyway." He pulls a couple of green shotgun shells from a pocket in his vest.

"They're the same two shells you had last year," Jenkins jokes.

"And the year before that and the year before that," Dick says. "Look at 'em. They're so slick because I keep taking them in and out of my gun."

Hunting in the Great Dismal Swamp National Wildlife Refuge is limited to a management hunt for white-tailed deer during the fall. On adjacent private lands, hunters stalk deer and other wildlife. Deer are plentiful here, and occasionally a hunter or camper will spy a bear.

On an earlier trip, George spotted a mother bear with twin cubs, born only a few days earlier. Fish and Wildlife employees say otters, bats, raccoons, minks, gray and red foxes, and gray squirrels are still common.

Dick and Jenkins say they haven't seen bears or bobcats in many years.

The three men drag chairs to a small table sitting at an odd angle on the slightly sagging floor. They swap hunting tales, most of them taller than the swamp's most famous lady, "The Witch." This huge Atlantic white cedar haunts the southeastern shore of Lake Drummond and casts an eerie silhouette against a full Dismal Swamp moon.

The hunters are strangely serious as they talk of the dangers of the great swamp and the deadly, deceiving trap it lays.

Dick, 75, has been hunting the swamp since he was 6. He recalls an era when hunting lodges surrounded Lake Drummond like charms on a watery necklace. At night, when the lanterns in those crude structures were blown out, darkness engulfed the lake and all who were brave enough to spend the night.

"I've seen it so dark out there you could cut it with a knife," Dick says. "You felt like you could push the darkness away from your face, it was so thick."

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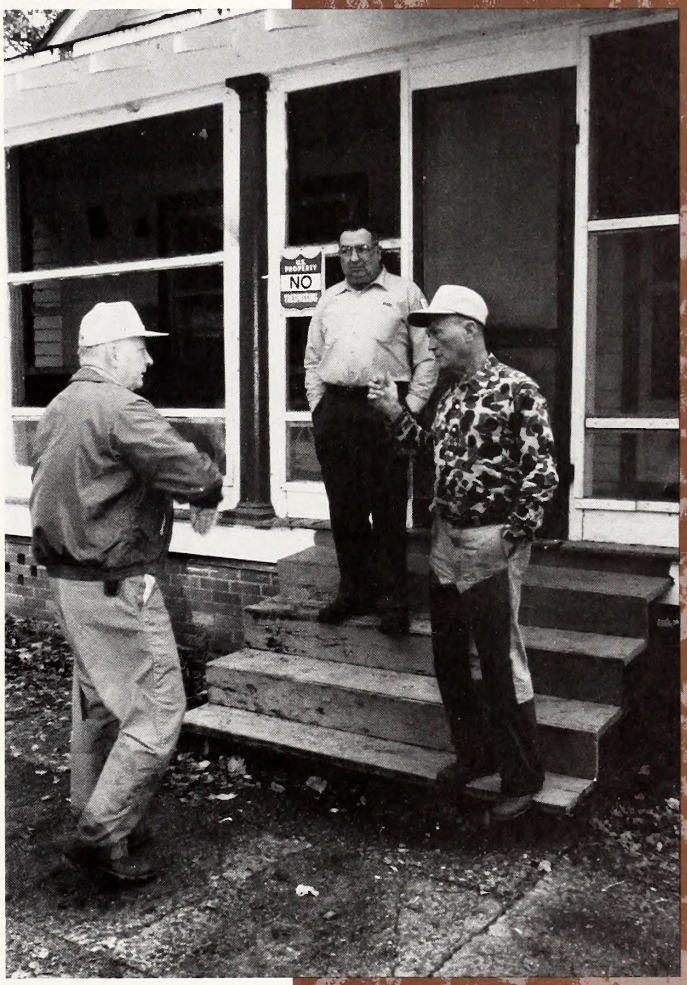
George P. Johnson



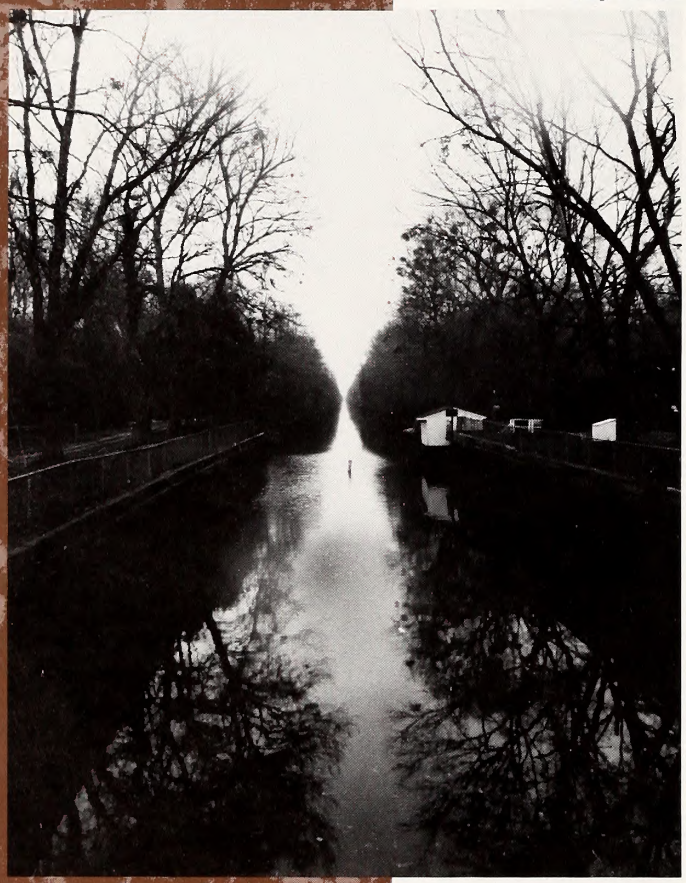
Ray Jenkins (center) talks to hunters.

Even experienced swampers feel the imposing power of the Dismal's deep secrets. And the bright light of day won't always assure you that the Great Dismal Swamp and its crowning jewel, Lake Drummond, can be tamed.

"Even if the sun is shining, you can get disoriented on the lake if you're not careful," Jenkins says. "I got lost recently, and I've been on that lake for 18 years."

Jenkins and Dick say few people will attempt to enter the almost impenetrable depths of the swamp with even a small degree of confidence.

George P. Johnson



Looking down the Feeder Ditch

Dick remembers a Navy pilot who, flying a jet in a training mission from nearby Portsmouth, lost control of his aircraft over the Great Dismal. The jet teetered and crashed near Portsmouth Ditch, clipping the tops of trees as it went down.

The Navy located the jet by helicopter, but no attempt was made to recover the pilot's body or the plane's radio equipment until Dick and another swamper agreed to head a search party into the morass.

Dick and his partner led a company of 20 sailors and two officers into the bramble, straight to the downed jet. "Not many people can do that in the Great Dismal," Dick says confidently, but with more than a hint of respect for the swamp in his voice.

He admits he's like a hundred others who have made their homes in or near the swamp. They're intimate with the lay of the land and the games nature plays there from time to time. They love the swamp, but know by experience that fickleness is the Great Dismal's middle name.

The two hunters finish their lunches, slurping down a last bite of stew. Then they lope back to the small kitchen and place a few dollars in a small dish on the counter, a familiar ritual for the pair.

"Well, I guess George and I will paddle out to the lake," I say, pushing my chair from the table. "The wind's picking up and the clouds haven't broken yet. But that shouldn't bother us on such a shallow lake."

Jenkins' face turns serious. "I wouldn't try it if I were you," he says. "If the wind's just right, the whitecaps on the lake will force you out of there in a minute. You don't want to be out there when that happens."

George and I note his advice but agree to give Lake Drummond a try anyway. It's a 10-minute paddle down the Feeder Ditch from campground to lake. When we get there, the clouds are darkening

and ominous. The wind calms a little, and the lake is a sheet of glass. We paddle a few hundred feet from shore, striking cypress roots with our paddles as we maneuver through the shallow waters. George snaps a few photos and makes a quick decision.

"Let's head back," he says. "I just can't forget what Ray said about the whitecaps. Things could change drastically in a few minutes."

As we reach the campground, Jenkins is cleaning up the lunch dishes with water from the outside faucet. He says the water comes from a well dug there on-site. He shows us a light amber-colored water, like weak tea.

"You can drink it," he says. "But I don't recommend it for cooking. It'll turn coffee black as ink."

The swamp's water has sired its own set of legends. The water was once a highly touted commodity. Its acidity discourages the growth of bacteria and other contaminants. That was a plus for early seagoing vessels, whose captains would order Dismal Swamp water for long journeys at sea.

Some say it'll cure what ails you; others warn about drinking it without boiling it first. We ask for some, and Jenkins disappears into his office. He comes out with a plastic gallon jug filled with water.

"It doesn't look like Dismal Swamp water to me," I say.

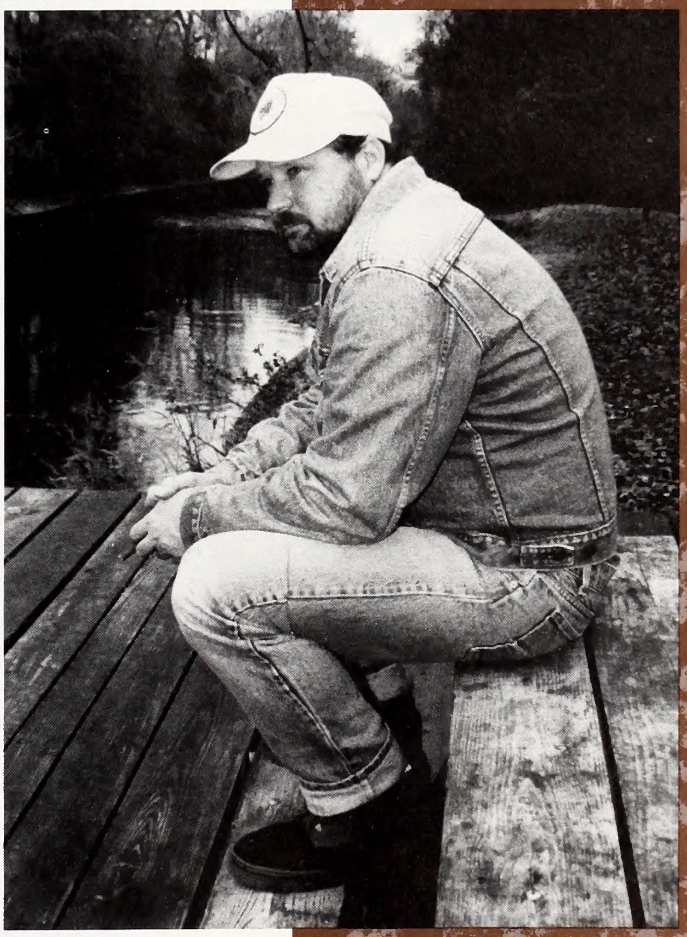
"That's because this is water from Ray Jenkins' kitchen faucet back in Chesapeake," he says. "Trust me; you'll like it better."

That night, I lie under the canopy of a starlit sky. Winds pick up and blow away the same cloud cover that made our day in the Dismal less than perfect. I hear the occasional drone of a Coast Guard helicopter from nearby Portsmouth or the swoosh of a jet from the Norfolk Naval Base. These sounds are soon drowned by heavy winds shooting into the swamp from the northeast, cutting across Lake Drummond like an F-15 jet and hitting the tops of the trees around the campground with a vengeance. The treetops roar like a locomotive convention as the huge gums, oaks and maples bend under the wind's awesome power. The sound keeps me awake for a while, thinking of the brave men who first traversed this morass called the Great Dismal.

"Hey George," I say between blasts of wind. "Listen to that. No wonder they call this the Great Dismal. That's kind of scary."

But George doesn't hear. He's snoozing away, zipped up tightly in his sleeping bag.

George P. Johnson



C.R. Edgerton

By the Compass or By Any Star:

North Carolina's Maritime Underground Railroad

by David Cecelski

In the decades before the Civil War, a slave named Peter guided vessels in and out of Wilmington harbor. Merchants and planters routinely depended on skilled local pilots and engineers like him to guide their ships safely around the dangerous shoals on the Cape Fear River and across its narrow, shifting channel into the Atlantic.

But Peter navigated more than freight through those treacherous coastal passages. He also secretly steered fugitive slaves toward freedom and played a vital role in a maritime section of the Underground Railroad that flourished in antebellum North Carolina.

"Peter enjoyed the friendship of two very distinguished Quakers, Mr. Fuller and Mr. Elliot, who owned oyster sloops and stood at the head of what is known in our country as the Underground Railroad," his son, an ex-slave named William H. Robinson, remembered in a little-known autobiography. "Father was with Messrs. Fuller and Elliot every day towing them in and out from the oyster bay. This gave them an opportunity to lay and devise plans for getting many [slaves] into Canada ... , and my father was an important factor in this line."

A correspondent to the *Wilmington Journal* underscored the success of the slave-smuggling conspiracy, writing in October 1849 that "it is almost an every day occurrence for our Negro slaves to take passage [aboard a ship] and go North."

Only recently have scholars begun to explore the complex and important roles played by black watermen and sailors in the antebellum past, where many African-Americans combined mobility, skill and solidarity to challenge the institution of slavery.

"Even at night," a former Currituck bondsman recalled, "I could

steer by the compass or by any star."

Nowhere was the magnitude of African-American influence on maritime life greater than among the vast sounds and estuaries that stretch 100 miles from the Outer Banks into the interior of North Carolina. Between 1800 and 1860, blacks composed about 45 percent of the total population in the 19 tidewater counties. Their importance in boating and shipping surfaces again and again in newspapers, plantation ledgers, personal diaries, court records and travel accounts of the day. By drawing on those sources, we can see how fugitive slaves and their collaborators, at sea and ashore, created an oceangoing route to freedom on the North Carolina coast.

Charting this clandestine corridor up the Eastern Seaboard also reveals a broader layer of tidewater culture long concealed by popular images of magnificent and tranquil plantations. More than just black watermen composed the Underground Railroad in coastal North Carolina. Although wealthy planters and merchants held the reins of power, drafting and enforcing the punitive laws, lowly watermen, slave stevedores, piney woods squatters, reclusive swampers and even slaveholders' wives and children defied those laws and forged a realm apart. This "underside of slavery" sustained tenuous pathways by which fugitives might pass from land to sea. Their conspiratorial acts represent a dramatic and untold chapter in the history of North Carolina.

We are fortunate to know anything about this "maritime Underground Railroad." It was, after all, an illicit undertaking, a potentially capital crime that necessarily occurred only on the fringes of society. Few dared to leave written accounts of their involvement; most who were apprehended had no day in court where their efforts might have been recorded. Historical documents understandably yield only the most oblique passages about slave runaways and their sympathizers.

"I was to escape in a vessel," wrote one ex-slave who had fled by ship, "but I forebear to mention any further particulars."

Or like William Robinson, they disclosed only enough details about the Underground Railroad to hint at its breadth and vitality, but deliberately omitted specific names, routes or ships.

Runaway slave Harry Grimes stayed in hiding in North Carolina swamp forests for 18 months before securing his passage to freedom on a ship in 1857. Engraving taken from William Still, The Underground Railroad: A Record of Facts, Authentic Narratives, Letters, etc., Narrating the Hardships, Hair-Breadth Escapes, and Death Struggles of the Slaves in Their Efforts for Freedom.

Yet documents unveil several dozen accounts of specific runaway slaves who reached ships sailing out of North Carolina ports between 1800 and 1861.

Most North Carolina slaves who tried to escape by ship traveled to the busier harbors at Wilmington, New Bern, Washington and Plymouth. Relying on their own watercraft skills

Continued

or on the ubiquitous black boatmen who plied the waters, fugitive slaves often followed rivers to those ports.

Most could not risk a long canoe or flatboat trip, even traveling only at night. But slaves escaped frequently enough by boat that when a Slocumb Creek man discovered a cypress dugout deserted by his home on Christmas Day, 1828, he simply assumed that the craft "must have been last in the possession of a runaway Negro." If they could not commandeer a boat, runaways depended on sympathetic fishermen and ferrymen, occupations usually held by slaves, to transport them across rivers, creeks and sounds.

Nowhere was the magnitude of African-American influence on maritime life greater than among the vast sounds and estuaries that stretch 100 miles from the Outer Banks into the interior of North Carolina. Between 1800 and 1860, blacks composed about 45 percent of the total population in the 19 tidewater counties. Their importance in boating and shipping surfaces again and again in newspapers, plantation ledgers, personal diaries, court records and travel accounts of the day. By drawing on those sources, we can see how fugitive slaves and their collaborators, at sea and ashore, created an oceangoing route to freedom on the North Carolina coast.

The largest town and finest harbor in antebellum North Carolina, Wilmington, had a special reputation as "an asylum for runaways." This was owed to its location near the mouth of the Cape Fear River, its steady sea traffic, its strong ties to New England and its majority black population.

Fugitive slaves followed the Cape Fear River to Wilmington from rice and turpentine plantations throughout southeastern North Carolina. They fled to New Bern along the Neuse and Trent rivers from cotton and tobacco fields as far inland as Kinston. And they trailed the Tar River to Washington and the Roanoke to Plymouth, from timber and herring camps stretching to the Virginia border. Slaves confined in the remote wetlands east of those major ports — in soggy Hyde and Tyrrell counties — often fled west to their wharves. And men and women who escaped from the Albemarle Sound vicinity frequently headed north through the Great Dismal Swamp to rendezvous with seagoing vessels in the Virginia ports of Norfolk or Portsmouth.

The larger ports were not the only destinations for fugitive slaves. Runaways and their allies extended the Underground Railroad into fishing hamlets and seafaring villages up and down the North Carolina coast. Henry Anderson, for example, escaped from a slave trader in Beaufort by ship. Miles White, only 21 years old, stowed away on a vessel carrying shingles from Elizabeth City to Philadelphia after convincing the captain to take the risk. Harriet Jacobs escaped by sea from Edenton in 1842. And in July 1856, Peter Heines, Mathew Bodams and James Morris all escaped on a schooner captained by a man named Fountain who met them at one of the rough-hewn villages along the Roanoke River or Albemarle Sound.

No matter which ports runaway slaves sought out, they faced many dangers before reaching the open sea. Bloodhounds, bounty hunters and port inspectors stood between their first steps in flight from bondage and the safety of the Gulf Stream's warm, northward currents. Escaping slaves risked life and limb around every turn. Slave catchers and patrol squads pursued them, and anyone could turn them in for a substantial bounty. Inspectors searched many seagoing vessels and, at points, regularly "fumigated" ships to drive hidden runaways onto the deck.

The chance of betrayal or discovery always existed, and many runaways never reached a ship or were caught before departure. Punishments included re-enslavement, public whipping, hard duty, deportation into the Deep South and death.

Confronted by so many pitfalls and deterrents, most slaves could only dream of the sea. Like the young Frederick Douglass, himself once a slave in a port town, they may have often mused about the "beautiful vessels, robed in white" that might "yet bear me into freedom." But throughout the plantation belt of eastern North Carolina, slaves tried to fulfill this dream frequently enough that their owners viewed the ocean as a serious threat and suspected that runaways might sail away.

Slave owners' preoccupation with the ocean's proximity often bordered on obsessiveness. Reward posters and newspaper advertisements routinely warned "masters of vessels" not to harbor, employ or carry away their departed workers. State penalties for protecting fugitive slaves were harsh; after 1793, ship captains risked hanging for carrying a runaway out of North Carolina.

Slaveholders also threatened seamen with civil prosecution for carrying away their slaves and offered extravagant rewards for information that would identify sailors who helped a slave flee. In February 1838, Gov. Edward Dudley offered up to $500 to anyone who would name the mariner who had taken his runaway slave from Wilmington to Boston.

Coastal geography and the willingness of many local inhabitants to protect runaways compounded for slaveholders the threat of the open sea and, for slaves, its lure. Remote swamps and dense forests offered ideal haven for runaway slaves who needed a long-term refuge, a point for hasty reconnaissance or a momentary way station en route to a port. Swamps, pocosins, pine savannas or tidal marshes encroached on every settlement in coastal North Carolina. Though their drainage and foresting was well under way by the early 19th century, those woods and wetlands promised a haven for fugitive slaves, many of them well-schooled in surviving in the wilderness.

To reach the sea, fugitive slaves could not rely on vanishing into coastal

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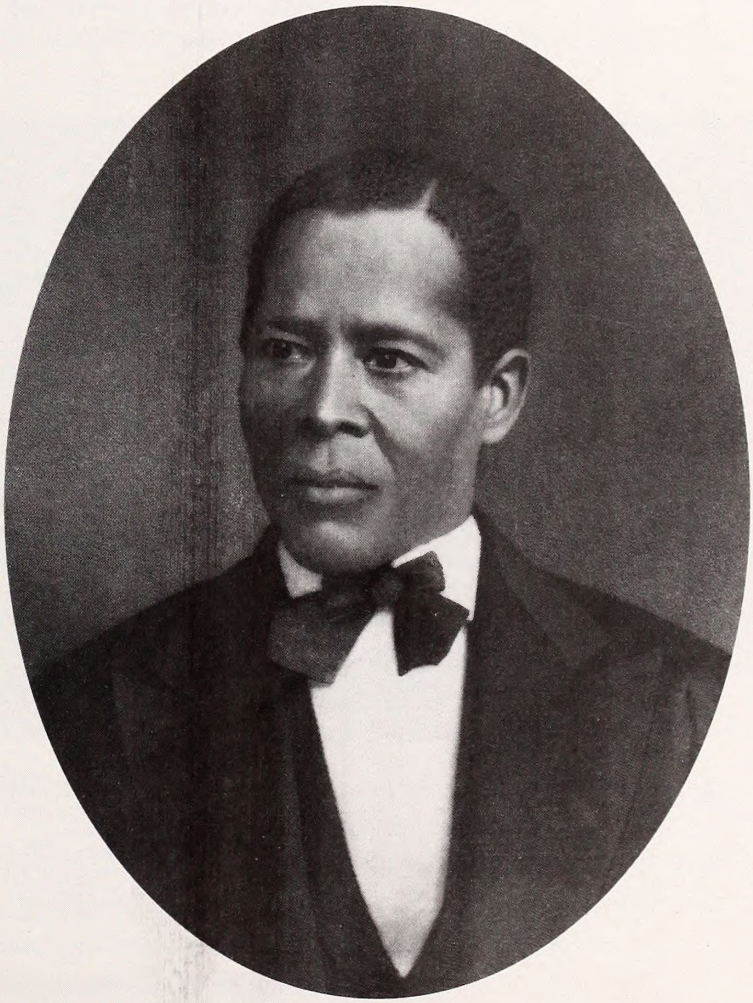

William Still, an African-American leader of the Underground Railroad in Philadelphia, helped a number of North Carolina slaves reach safety in the Northern states and Canada. Portrait taken from Still, Underground Railroad.

swamps and backwoods. Even when they possessed the skills necessary for wilderness survival, a hermit's life did not provide access to critical information about sea traffic or the contacts necessary to reach a ship. As a result, runaways usually had to rely on the complicity of men and women prepared to disregard the slave laws. All runaways, but especially those who planned to board a ship, looked to clandestine networks of slaves and free persons. From the vantage point of the state's leaders, those networks remained a dangerous and ephemeral world beyond the edges of their towns and plantations.

The Great Dismal Swamp and its waterways provided protection and a means of communication and mobility for refugee slaves. This is an engraving of African-American workers on the Dismal Swamp Canal from Harper's New Monthly Magazine *(May 1860).*

Fugitive slaves found their most important backing from other slaves.

"The slaves generally know where the runaway is secreted and visit him at night and on Sundays," remembered Nehemiah Caulkins, a white carpenter who closely observed daily life on several rice plantations near Wilmington between 1824 and 1835.

Peter's son Robinson, himself a one-time runaway, remembered the assistance that slaves gave to their fugitive brethren in Wilmington.

"There was always an understanding between the slaves that if one ran away they would put something to eat at a certain place," Robinson recalled in his autobiography. He wrote that the slaves would leave out a mowing scythe for their escaped comrades, replacing the crooked handle with a straight stick to fend off bloodhounds.

Over weeks, months and even years, slaves supplied refugees with provisions and intelligence to help them elude their pursuers. For this kind of help, fugitive slaves looked most often to family members who remained with their former masters or who had been sold in the vicinity.

Despite efforts to restrict them, slaves developed ways to communicate and travel. Slave watermen, couriers and draymen traveled widely and could secretly convey messages and goods over long distances. African-Americans also took advantage of limited free time to create cultural and social networks, out of sight of their owners, that linked slaves over a wide territory.

"Night," recalled Allen Parker of his years in bondage by the Chowan River, "was the slave's holiday."

Though discovery meant severe punishments, slaves often moved about surreptitiously in the evening hours, visiting friends and family on other plantations, worshiping, courting and trading illicitly. Those nocturnal forays not only sharpened their ability to dodge slave patrols and bloodhounds, but also stretched the boundaries of their bondage and identified blind spots in the vigilance of their owners. Maintaining a liaison between a slave quarters and a swamp or forest hideout required the utmost secrecy and entailed great risks. But those who colluded with runaways knew how to maneuver along well-worn cracks in slavery's walls.

Runaway slaves also depended on

kindred souls concealed in the swamps and pocosins of the coastal Carolinas. Slaveholders attempted repeatedly, and usually with great brutality, to eliminate those defiant individuals; but "maroons" continued to inhabit the North Carolina coast to a degree that scholars may never fully know.

When William Robinson escaped from an abusive master in 1858, he immediately sought out the protection of a group of fugitive slaves living in the nearby swamps. His knowledge of their hideout had begun during his early childhood. "I had often heard ex-runaway slaves, men and women, tell the adventures of when they were in the woods and about their hiding places or rendezvous," Robinson wrote. "I had heard it so often at my father's fireside that I knew almost directly where they were, for I had passed close by them many times."

Robinson fled to the "three-mile farm" on the edge of a swamp near Wilmington, where he asked an elderly slave woman for the precise location of the refugee camp. This woman — Robinson reverently called her "mother" — gave him food, a blessing and directions to the fugitive encampment. He found 18 people hidden that night on a rock outcrop shielded by a large cane break deep within the swamp. Robinson and his companions foraged for food and relied on friendly slaves to help them.

Black men and women on the run found similar support in coastal areas beyond Wilmington. In 1830, 30 to 40 fugitives had established a base in Dover Swamp in western Craven County. They had opened lines of communication to several other runaway camps as far away as the Newport River, more than 35 miles to the east.

Similarly, in the mid-1850s, runaway slaves enjoyed what petitioners to the governor called a "very secure retreat" in Brunswick County's Green Swamp, then one of the largest swamps in North America. They had built at least 11 cabins and carved out a garden and grazing area in the midst of the swamp, as well as enough embattlements that white raiders failed to overrun the camp in the summer of 1856. Afterward, local planters were unable to recruit slave hunters willing to make another foray into the swamp.

The immense, boggy wilderness that extended from Albemarle Sound and the Chowan River into the Great Dismal Swamp had a special renown for refugee camps that shielded escaping slaves. One sea captain who sailed the Albemarle called it "a slave territory that defies all the laws." Records document his observation. In 1802, for example, a runaway named Tom Copper had established a swamp hideout near Elizabeth City from where he led raids on local plantations. Relying on slave boatmen who worked the Albemarle waterways, Copper reportedly conspired with runaways and other slaves more than 100 miles away.

Visiting the Great Dismal in 1853, the famous landscape architect Frederick Law Olmsted heard about phantom colonies of fugitive slaves whose children had been "born, lived

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More than just black watermen composed the Underground Railroad in coastal North Carolina. Although wealthy planters and merchants held the reins of power, drafting and enforcing the punitive laws, lowly watermen, slave stevedores, piney woods squatters, reclusive swampers and even slaveholders' wives and children defied those laws and forged a realm apart. This "underside of slavery" sustained tenuous pathways by which fugitives might pass from land to sea. Their conspiratorial acts represent a dramatic and untold chapter in the history of North Carolina.

and died" in the swamp. To ocean-bound fugitives, maroon camps provided temporary shelters and opportunities to learn from experienced fugitives how to navigate the many obstacles to a port.

Fugitive slaves bound for the sea also found allies among free men and women. Seeking help from free collaborators was always dangerous and rarely a first resort. When Parker ran away from a harsh master, he could only find haven with an impoverished white woman whom his mother had befriended. Although runaways sought asylum more often among the poor and dispossessed, people of other backgrounds also aided them.

No matter which ports runaway slaves sought out, they faced many dangers before reaching the open sea. Bloodhounds, bounty hunters and port inspectors stood between their first steps in flight from bondage and the safety of the Gulf Stream's warm, northward currents. Escaping slaves risked life and limb around every turn. Slave catchers and patrol squads pursued them, and anyone could turn them in for a substantial bounty. Inspectors searched many seagoing vessels and, at points, regularly "fumigated" ships to drive hidden runaways onto the deck.

Thomas H. Jones, for instance, conspired with free worshipers at his Methodist church to arrange his family's escape from Wilmington. In Chowan County, an upper-class white woman who had long been a family friend concealed Harriet Jacobs. In 1848, a Wilmington merchant named Zebulon Latimer contrived his own slave's escape to New York.

Reviewing most such accounts today, one can only guess at personal motivations. But clearly, runaways recognized and exploited a variety of forbidden bonds that connected the slave community and free citizens.

Those who dared to flee ultimately faced the formidable task of connecting with sympathetic seamen or other coastal residents who could help them obtain a secret berth to freedom. Finding passage on a ship to free territory could take months or years. A single wrong step, misplaced trust or slightly rash inquiry could doom a runaway slave. Success depended as much on patience and prudence as daring and courage.

Harry Grimes, for example, hid in North Carolina swamp forests for 18 months before securing his passage to freedom on a ship in 1857. The slave Ben Dickenson waited and eavesdropped on harbor conversations for three years until the right opportunity arose to stow away. Jacobs hid in an Edenton attic for seven years before friends and family arranged her passage to Philadelphia.

Word of a vessel's master or crew that would harbor runaways spread quickly from ship to ship, along the docks and from ports into their hinterlands. Gossip and reality no doubt mingled in precarious measure. In 1857, Abraham Galloway and Richard Eden, two young bondsmen, timidly approached the captain of a Wilmington schooner bound for Philadelphia. According to William Still, a black leader of the Underground Railroad in Philadelphia, their conversation "had to be done in such a way that even the captain would not really understand what they were up to, should he be found untrue."

By sly indirection, Galloway and Eden had found a captain willing to conceal them amidst barrels of turpentine, tar and rosin for the northward passage. But they were fortunate. He could just as well have collected a

reward on them or kidnapped and sold them back into slavery in another Southern port.

The experience of Peter and the two Quaker oystermen with whom he collaborated illustrated the intricate planning required to reach a ship. Peter belonged to an elite corps of black pilots on whom much of coastal transport had relied since the Colonial era. His master, a prominent merchant in town, allowed Peter to work by himself, to manage his own affairs within bounds and to solicit jobs freely in the harbor in exchange for most if not all of his piloting fees. This practice, a version of "hiring out," was a controversial but common arrangement in coastal ports for skilled slaves with a profitable trade requiring a high measure of autonomy.

Despite the terrible risks, Peter put his watercraft skills and independence at the disposal of fugitive slaves. He worked closely with the two Quaker abolitionists Samuel Fuller and "Mr. Elliot," piloting their oyster sloop through local bays and sounds. Deeply enmeshed in harbor life, the three watermen could identify mariners who might convey escaping slaves away from Wilmington.

Free black sailors, in particular, proved to be key collaborators.

"They are of course," wrote the *Wilmington Aurora* editor, "all of them, from the very nature of their position, abolitionists, and have the best opportunity to inculcate the slaves with their notions."

Runaways contacted the trio through Peter, who was well-known among local blacks and was readily approached in the wharf district, or through the many other black watermen, stevedores, ships' artisans or hawkers with whom they dealt in their oyster business.

The success of Peter and his co-conspirators hinged less on their own unique skills than on more general qualities of maritime slavery in North Carolina. The harsh restrictions enforced on plantation labor gangs broke down in a maritime economy so thoroughly reliant on slave watermen for travel, trade and communication. Close supervision or regular surveillance proved impractical: too many slave watermen performed too many important jobs over too wide and remote a coastline. And the methods used to exact slave productivity on land did not stand up well before the unpredictable forces of wind and tide.

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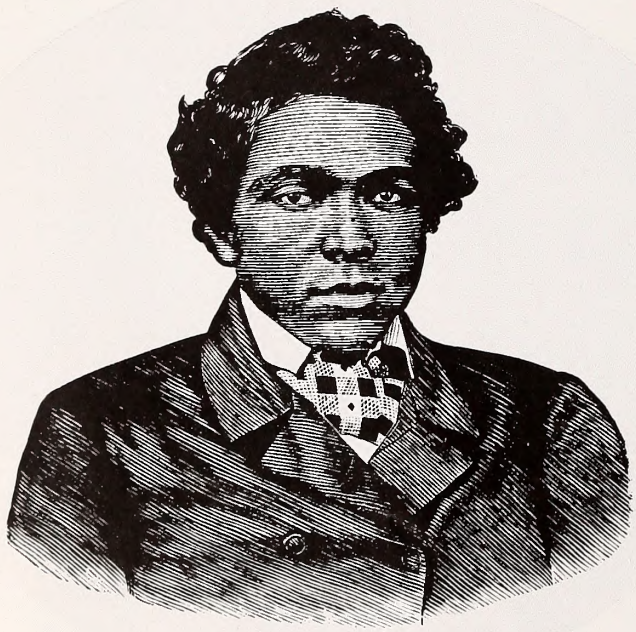
After concealing herself in an Edenton house for seven years, Harriet Jacobs escaped with the help of a free black friend for a substantial sum paid to the ship captain who transported her to Philadelphia. Drawing by Keith White; photograph from the N.C. Division of Archives and History.

Confronted with this uncertainty and a heavy reliance on African-American maritime skills, merchants and planters usually had to concede slave watermen an exceptional degree of leeway to conduct their business and a variety of special rights and privileges.

Though black Carolinians fled by ship up to 1861, and even on blockade runners leaving Wilmington during the Civil War, the maritime Underground Railroad was always fragile. It could, in fact, collapse at any time.

Suspected of abusing his privileged status by planning his own and other slaves' escape, Peter was eventually sold into the Deep South; he never saw his wife or children again. Suspicious slaveholders also pointedly threatened Fuller and Elliot, and they warned local overseers not to allow the two oystermen to speak with slaves. Soon after discovering a skull and crossbones on the door of his home, Fuller vanished from Wilmington. His family assumed that vigilantes had murdered him for his activities on behalf of fugitive slaves.



Abraham H. Galloway fled from Wilmington by sea as a young slave in 1857, returned to North Carolina as a Union spy during the Civil War and later represented New Hanover County in the state Senate. Engraving taken from Still, Underground Railroad.

From Colonial days onward, the shores of North Carolina frustrated slaveholders. Small harbors, shallow sounds and treacherous inlets prevented the development of a major port and inhibited the growth of the state's plantation economy. The Outer Banks and the tremendous shoals that extended far out onto the continental shelf, the "Graveyard of the Atlantic," posed a constant threat to shipping. But the hazardous coastline that seemed so inhospitable to slaveholding merchants and planters provided their black workers with hope of passage to freedom.

The forgotten courage and ingenuity of slave watermen, seamen and other coastal residents clearly merits greater attention today. But we must also look beyond the relatively few slaves who managed to escape by sea to the broader aspects of coastal culture that sustained their clandestine current out of the South.

Coastal slaves and many free persons did not accept the boundaries of slavery. Instead, they found ways to carve out an independent life in defiance of the prosperous slaveholders who ruled North Carolina. Looking further at those dissidents will reveal much about our coast, then and now.

This article first appeared in The North Carolina Historical Review *in April 1994. This is an edited version.*

H • O • L • I • D • A • Y

Taste Treats

By Joyce Taylor, Sea Grant Seafood Education and Safety Agent

With the holiday season at hand, many cooks are looking for fresh ideas for hors d'oeuvres. Whether you're having a big party or a small gathering, let seafood be part of your menu.

You can serve a diverse selection of appetizers when you use seafood. And since many seafood preparations are light, your guests can enjoy them and still look forward to the main course.

Or you can serve a selection of seafood appetizers, in combination with other foods such as raw vegetables, crackers and fruit, as a light meal. Some hors d'oeuvres, such as *Baked Oysters with Bacon*, can be a main course.

Plan to have mostly cold appetizers with only a few hot ones. Then you can enjoy your guests with minimal time in the kitchen.

Some of the simplest appetizers are also the tastiest. And many, such as cold spreads and dips, can be prepared ahead of time. In fact, they're often better when made a day before serving.

Many popular publications contain recipes for seafood appetizers. But I find that many of them are not well-tested and are often not as good as they sound. And often they are complex and time-consuming to prepare.

The recipes that follow have been evaluated. We use a scale of 1 to 5 (5=excellent, 1=poor). All recipes have a 4.5 or higher rating.

Enjoy seafood hors d'oeuvres during the holidays and all year.

Shrimp Dip

1 1/2 pounds small or medium shrimp
3 ounces cream cheese, softened
1/2 cup mayonnaise
3 tablespoons finely chopped onion
1 1/2 teaspoons prepared mustard
2 tablespoons fresh lemon juice
1/2 teaspoon Worcestershire sauce
1/4 teaspoon Tabasco sauce
1 cup light cream

Cook shrimp in salted or seasoned water. Drain, peel and devein. Chop finely. (Food processor works nicely.)

Combine cream cheese and mayonnaise. Add onion, mustard, lemon juice, Worcestershire and Tabasco. Blend in cream and mix until smooth. Add shrimp. Chill. Serve with assorted vegetables. May also be used as a spread with crackers. Makes about 3 cups.

Marinated Shrimp With Fine Herbs

1 pound large shrimp
1/2 cup margarine
1/2 cup vegetable oil
1/4 teaspoon Tabasco sauce
1 bay leaf
1 teaspoon pressed garlic
3 tablespoons fresh lemon juice
1 teaspoon parsley
1 teaspoon chives
1/2 teaspoon tarragon
1/2 teaspoon chervil
1 1/2 teaspoons Worcestershire sauce
1/2 teaspoon freshly ground black pepper

Cook shrimp in salted water. Drain, peel and devein.

Melt margarine in medium saucepan. Add oil, Tabasco, bay leaf, garlic, lemon juice, parsley, chives, tarragon, chervil, Worcestershire and pepper. Bring to a boil, reduce heat and simmer for 5 minutes. Remove from heat.

Add shrimp to sauce. Marinate in the refrigerator 1 hour. Spoon onto serving dish with slotted spoon.

Tangy Crab Dip

1 cup backfin crabmeat
8 ounces cream cheese, softened
1/2 cup light sour cream
1/2 cup mayonnaise
1 tablespoon fresh lemon juice
1/4 teaspoon Tabasco sauce
4 tablespoons minced green onions, including tops
1/2 teaspoon pressed garlic
1 teaspoon horseradish

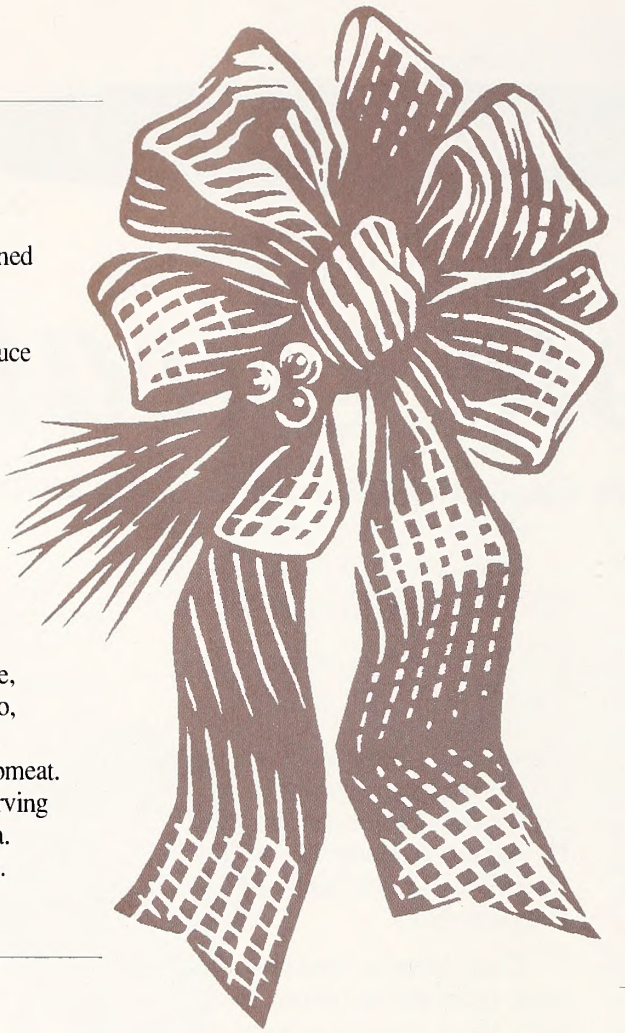
Combine cream cheese, sour cream and mayonnaise. Add lemon juice, Tabasco, onion, garlic and horseradish. Gently fold in crabmeat. Chill thoroughly. Serve with chips or assorted crackers. Makes about 2 1/2 cups.

Continued

Creamy Crab Dip

1 pound backfin crabmeat
12 ounces cream cheese, softened
1/2 cup light cream
4 teaspoons fresh lime juice
3 teaspoons Worcestershire sauce
1 teaspoon pressed garlic
1/4 teaspoon Tabasco sauce
4 teaspoons finely chopped fresh parsley
1/2 teaspoon freshly ground white pepper
paprika

Blend cream and cream cheese together. Add lime juice, Worcestershire, garlic, Tabasco, parsley and white pepper. Mix thoroughly. Gently fold in crabmeat. Chill thoroughly. Place in a serving bowl and sprinkle with paprika. Serve with assorted vegetables. Makes about 3 cups.



Baked Oysters With Bacon

24 large unshucked oysters
6 slices reduced salt bacon
1 cup fresh cracker crumbs
1/2 cup mayonnaise
2 tablespoons chopped green onion, including tops
1 teaspoon fresh lemon juice
1 teaspoon Tabasco sauce
1/2 teaspoon Dijon mustard
1/2 cup freshly grated Parmesan cheese
rock salt

Wash oysters thoroughly. Shuck, reserving deep half of shells. Drain oysters.

Cut bacon slices into quarters. Cook until limp, but not brown. In small bowl, combine crumbs, mayonnaise, onion, lemon juice, Tabasco and mustard.

Place deep layer of rock salt in bottom of a large pan or baking dish. Arrange reserved shells in rock salt, being sure that they are level. Place one oyster in each shell. Spread crumb mixture over each. Top with a piece of bacon, then sprinkle with cheese. Bake at 400 F until bacon is crisp, about 8 to 10 minutes. Makes 24 appetizers.

Smoked Fish Spread

1 pound smoked fish
1 pound cream cheese, softened
2 tablespoons fresh lemon juice
2 tablespoons finely chopped onion
1/4 cup chopped sweet pickles
1/2 cup finely chopped celery
4 tablespoons horseradish
1/2 teaspoon Tabasco sauce
1/4 cup chopped fresh parsley
3/4 cup light cream

Flake fish. Blend together cream cheese, lemon juice, onion, pickles, celery, horseradish, Tabasco and parsley. Add fish. Blend in cream. Serve with crackers. Makes about 3 cups.

Hot Crab Dip

1 pound backfin crabmeat
8 ounces cream cheese, softened
1 tablespoon milk
2 tablespoons grated onion
1 tablespoon fresh lemon juice
1 teaspoon horseradish
1/4 teaspoon freshly ground white pepper
paprika

Mix cream cheese, milk, onion, lemon juice, horseradish and pepper. Gently fold in crabmeat. Place in 8-inch pie dish. Sprinkle with paprika. Bake at 350 F for 15 to 20 minutes or until bubbly. Serve with assorted crackers.

Crab-Stuffed Tomatoes

1 cup backfin crabmeat
1 pound cherry tomatoes
2 tablespoons finely chopped green onion, including tops
1/4 cup mayonnaise
1 teaspoon fresh lemon juice
1/4 teaspoon salt
1/4 teaspoon freshly ground white pepper
1/2 teaspoon Tabasco sauce
fresh parsley sprigs

Wash, dry and hollow tomatoes. Invert and drain on paper towels. Mix together mayonnaise, onion and lemon juice. Add salt, pepper and Tabasco. Gently fold in crabmeat. Stuff tomatoes. Chill thoroughly. Garnish serving dish with parsley sprigs. Makes 25 to 30 appetizers.

Coastal Fishing: Know Your Limits

It used to be saltwater fishing was like a game of chance at a carnival. You'd bait your line with anything handy, toss your lure into the waves as far as you could muster, then wait to see what grabbed hold. Whatever fish surfaced was good for the frying pan.

But these days, anglers have to know a little more than the location of the nearest bait and tackle shop. Fishery management organizations, charged with preserving the balance between the number of fish available and the number caught, make laws governing the catch. To be a responsible angler — and avoid a ticket — you need to bone up on current rules and regulations.

"The day is gone when you can come down to the beach and catch anything," says Sea Grant fisheries agent Jim Bahen. "You better know your fish, you better have a ruler and you better know your regulations."

For instance, there's a five-fish catch limit on king mackerel in state waters, and the fish must measure 20 inches in fork length. A Spanish mackerel must measure at least 12 inches, and you can fill your cooler with up to 10 each day. Got that?

Now, keep in mind that a juvenile king mackerel looks a lot like a small adult Spanish mackerel. Careful scrutiny of the fish's lateral line and the size of its eye should clear up any doubt.

On to that flounder you've just hooked. Can you keep it in good conscience? In Pamlico Sound — "inshore" waters — if the fish is 13 inches or longer, you can. But trek across to the beach at Hatteras — ocean waters — and the same fish would have to measure at least 14 inches in total length. And that's only if you catch it between May 1 and Dec. 31, the state season for hook-and-line flounder fishing in the ocean. You can fish for flounder in the estuaries year-round.

And did we mention that any of this may change by the time you read this?

Don't be daunted. It is possible to be a conservation-minded angler without night school. You just need a few tools, most importantly the free recreational catch chart compiled by Bahen. It lists the catch limits and harvest lengths for 35 popular marine fish. It also includes biological data to help fishermen fathom the reasons behind the regulations.

"Sea Grant educates people not only on what the new regulations are, but also kind of gives some explanation as to why they're there," says Bahen. "A lot of people wonder, if I caught this little bluefish and he's 9 inches, why should I put him back?"

At sexual maturity, bluefish usually measure between 12 and 14 inches. Releasing the 9-inch bluefish would give it a chance to mature, spawn and proliferate. Size limits placed on fish usually correlate with the fish's position on the reproductive spectrum.

"Striped bass might take five or six years to reach that point, whereas spot, croaker or bluefish might take one or two years," says Bahen. It's important to allow fish to spawn several times before harvesting, he says.

Biologists know the ages, lengths and weights of each species at spawning and use them to make management recommendations. They also determine a total allowable catch (TAC) of a given species.

"You take this pot of fish, and you know that some of them are juveniles not able to spawn, some are in the first year of reproduction and some are older fish," he says. "Biologists have determined how many of those fish 12 inches or greater you can take out of the pot and still keep the population healthy."

Managers set TACs, measured in pounds, for commercial harvest and bag limits for recreational catch. The N.C. Marine Fisheries Commission determines the catch limits and minimum harvest sizes for fish caught in state waters — estuaries and ocean waters up to three miles offshore. The South Atlantic Fishery Management Council establishes the same kind of rules for federal waters — from three miles to 200 miles offshore. Recently, the Atlantic States Marine Fisheries Commission entered the regulatory arena, establishing management plans for species that migrate between states in nearshore waters.

Because of the dynamics in population and harvest, any of these organizations may change length requirements or close fishing of a particular species. Bahen stays on top of the changes, keeping Sea Grant's chart current.

He offers these suggestions for landing citation-size fish:

- Keep a tape measure in your tackle box or use a cooler with a built-in measurement scale. For quick reference, measure a 12-inch section of your rod to use as a guide. When measuring fish, lay your catch onto your scale. Otherwise, as in the case of a species with a thicker belly, placing a tape measure flush with the fish could distort the length.
- Depending on the species, minimum size is expressed in fork length (FL) or total length (TL). Fork length is measured from the tip of the fish's lower jaw (mouth closed) to the fork or indentation in its tail. In billfish, you would disregard the upper protrusion, measuring from the underbite. Total length is measured from the tip of the nose to the tip of the tail.
- If you're unfamiliar with marine fish, pick up a field guide in the Peterson series or Charles Manooch's *Fisherman's Guide: Fishes of the Southeastern United States.* Look for a well-organized book with color photographs and key identification markings such as lateral lines and spots.
- Be aware that common names of species vary by locale. Depending on the region, whiting is known as Virginia mullet, sea mullet or northern kingfish; redfish, puppy drum and channel bass all describe the same species; striped bass and rockfish are one and the same.

For a free copy of A Recreational Guide to Management of Fish in South Atlantic Waters *or the supplementary snapper-grouper chart, write Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695. Or call 919/515-2454.*

Currituck Struggles with Saltwater Intrusion

The health of Currituck Sound is failing.

The vast beds of wild celery, widgeongrass, pondweed and Eurasian watermilfoil that flourished in its fresh waters are now withered by the sting of salt water. In turn, the loss of critical habitat has taken a toll on the fish, crabs, ducks and geese that seek refuge and food in the sound.

Currituck is losing its draw as a paradise for sportsmen and naturalists.

"The causes are difficult to pinpoint and correct," says Barbara Doll, N.C. Sea Grant's coastal water quality specialist. "There are major gaps in our field of knowledge — unanswered questions and lack of information — that make management of the sound a challenge."

Among the challenges is whether to manage Currituck Sound as a freshwater or saltwater system. Before 1830, it was a saltwater ecosystem. That began to change, however, when the Old Currituck Inlet at the North Carolina-Virginia border closed and the sound began to freshen. Today, Currituck and Back Bay are managed as freshwater systems, although recent increases in salinity have posed the possibility that the area might be returned to a marine ecosystem.

The sound's future is also clouded by the lack of a management plan for its entire drainage system. A shallow finger of water, Currituck extends to the northernmost boundary of the Albemarle-Pamlico estuarine system, where it's fed by the North Landing and Northwest rivers. It drains large portions of Virginia with expanses of heavy development. Canals dredged for the Intracoastal Waterway, flood control and agriculture link the sound to the Chesapeake Bay and the North River. As a result, many different agencies regulate activities within portions of the sound, but no single agency or group of agencies cooperates to manage the drainage basin as a whole.

Yates Barber, a biologist and resource conservationist, says the importance of the sound to Currituck County, North Carolina and the entire mid-Atlantic has been neglected for too long. His opinions are grounded in 50 years of personal and professional experience on these waters.

At one time, Barber says, Currituck's 100,000 surface acres of fresh water, combined with Back Bay's 26,000 acres, were the most productive black bass recreational fishing grounds on the East Coast. But by 1988, virtually all of the vegetation was gone and, with it, the famous black bass fishery.

Salinity was identified as the culprit. The blame was cast on multiple causes: a severe local drought, the hourly pumping of 1 million gallons of salt water from the ocean into Back Bay, the reduced flow of 10 million gallons daily from Northwest River, and saltwater intrusion from Chesapeake Bay by way of Virginia Beach Canal Number 2.

The practice of pumping salt water into Back Bay had ended by September 1987, and in 1989, the drought broke with rainfall some 40 to 50 percent above the normal 45 inches per year. These changes offered hope that Currituck Sound and Back Bay would again freshen, aquatic vegetation would recover and black bass and other fish would return.

Unfortunately, Barber says, there has been only limited progress toward recovery. In 1992, volunteer monitoring through the Albemarle-Pamlico Estuarine Study recorded salinities high enough to kill black bass eggs and wild celery, an important food for waterfowl. Monitoring by the N.C. Wildlife Resources Commission has turned out similar findings.

But it's still too early to rule out the possibility that normal rainfall will return salinities and the bass population to suitable levels, Doll says.

Sampling by the Wildlife Resources Commission has shown excellent recruitment for newly hatched bass during the last three years. Catches haven't improved yet, probably because bass grow slowly in saline environments. But fishing should improve in the next year or two if salinities remain relatively low.

Barber, however, theorizes that the plants critical to fish and other wildlife will be slow to recover.

First, he says, salt water continues to invade Currituck Sound through Coinjock Canal. The canal is a dredged portion of the Intracoastal Waterway that connects the sound to the North River, a tributary of Albemarle Sound. Since the canal was built in 1859 and enlarged in 1920, water has exchanged between the North River and Currituck Sound, but both waters have been mostly fresh in the past.

So why is Coinjock Canal now so salty? The explanation may lie in low freshwater flows, perhaps another reason for a slow recovery.

Barber suspects fresh water is being diverted from the upper basin of the North River to the Pasquotank River. Historically, thousands of acres of the southern Great Dismal Swamp had been drained by the North River. But recent aerial photos show vast drainage and land-clearing operations that may have redirected large quantities of water from the Dismal Swamp to the Pasquotank River. As a result, reductions in fresh water have allowed salt water to creep into the mouth of the North River, through Coinjock Canal and eventually into the upper Currituck Sound.

But how this inflow of salt compares to other sources such as the Chesapeake Bay remains unknown. The tributaries of the bay are linked to Currituck Sound through the Intracoastal Waterway and other canals.

Whatever the causes, the problem is complicated by a scarcity of records on water quality and quantity for North River, Currituck Sound, Back Bay and their tributaries. Likewise, there are essentially no baseline records of circulation and tidal movement in the sound.

"In my opinion, Currituck Sound is paying the price of the failure over the years to adequately monitor North Carolina's coastal waters," Barber says. "The few existing records have been collected recently through the Albemarle-Pamlico Estuarine Study. Had adequate monitoring been in place long before, a baseline would have existed to detect changes as they began to occur. Investigations and corrective actions could have followed."

Without data, the sound has no compass for directing repairs, but some efforts have been undertaken nonetheless.

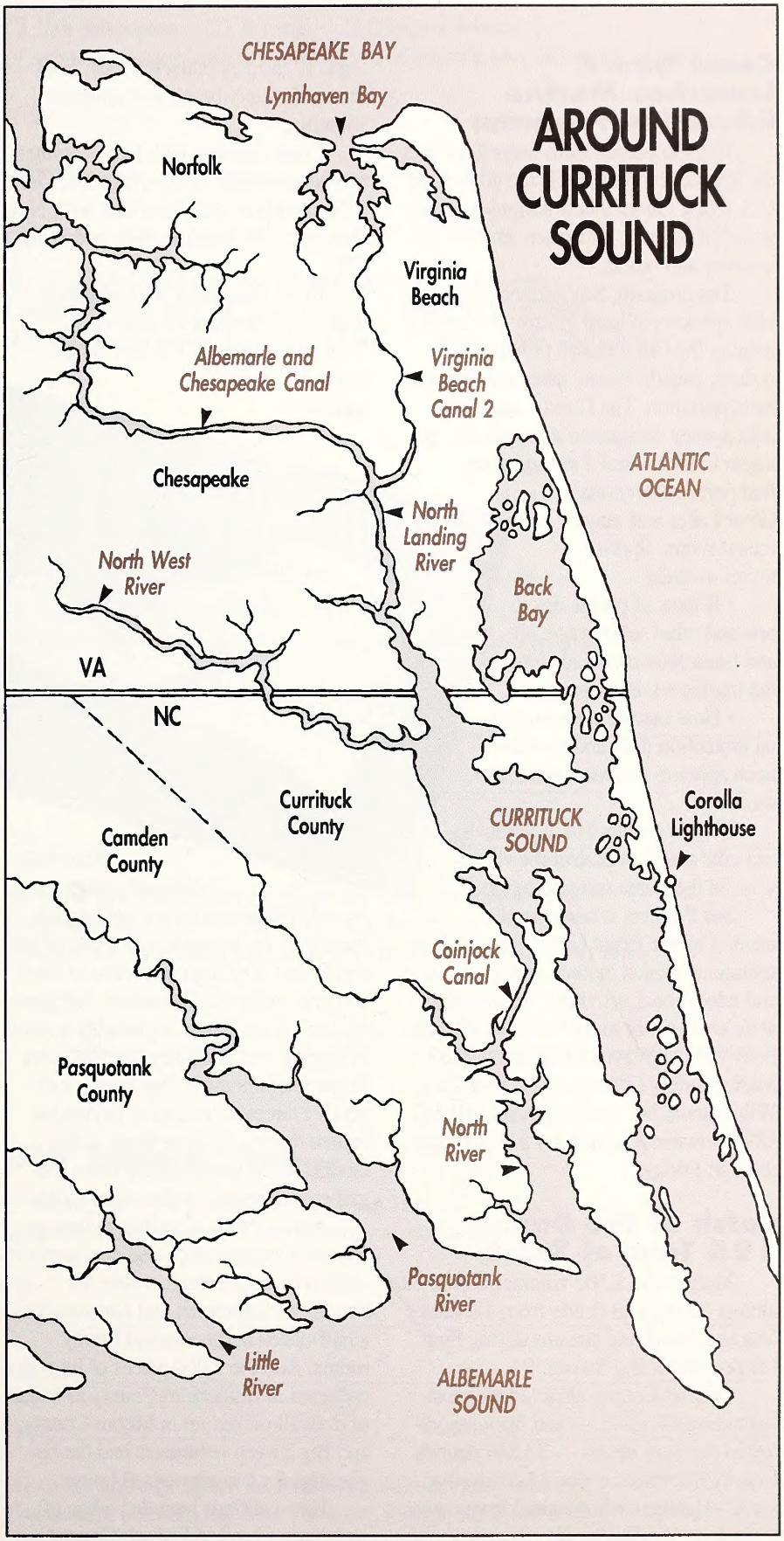
For example, the U.S. Soil Conservation Service has tried to restore freshwater inflows. It has been working with a large farm near Elizabeth City to install flashboard riser systems, which imitate natural drainage conditions.

There have also been discussions about diking a nearby spoil area to reduce turbidity, another obstruction to the recovery of sound plants. The dredged material is generated by maintenance of the Intracoastal Waterway along the Virginia portion of the North Landing River. It's possible that the wakes of passing tugboats, barges and other large vessels continually resuspend these fine materials. Consequently, water clarity and light penetration are reduced to only a few inches in most areas.

For now, the sound endures fluctuating salinities that are not fresh enough for bass and not salty enough for an estuarine-type ecology. Without efforts to understand and correct the problem, Currituck Sound will never recover to the productive state of past generations, Barber says. The exact sources and amounts of salt water delivered to the sound must be determined, and active measures must be taken to cut off the salt and restore freshwater inflows. Activities that increase turbidity should also be minimized.

"Currituck Sound has been brought to its lowest point in history," Barber says. "It may take years to recover."

Jeannie Faris



Coast Guard Launches Marine Education Program

Helping people learn ways to protect the marine environment is the goal of the U.S. Coast Guard's new nationwide program for schools, fishermen, boaters, industry and others.

The program, Sea Partners, will provide speakers to local groups interested in helping the Coast Guard protect our oceans, sounds, rivers, lakes and streams from pollution. The Coast Guard is the lead agency designated to respond to pollution in the coastal zone and specified ports on America's Great Lakes and major inland rivers. Specific topics include:

- Effects of plastic debris and other solid waste, oil and hazardous chemicals on the marine environment.
- How marine environmental protection laws and regulations apply to various maritime users.
- Ways groups and individuals can take action to protect the waterways in their area from pollution.

Sea Partners is being implemented by the Coast Guard Reserve. Presentations, which include slides, videos and educational activities, are available at no charge. For more information, write Petty Officer Wayne Chapman, USCG Marine Safety Office, 272 N. Front St., Wilmington, NC 28401. Or call 910/343-4895 between 8 a.m. and 4 p.m. Monday through Friday.

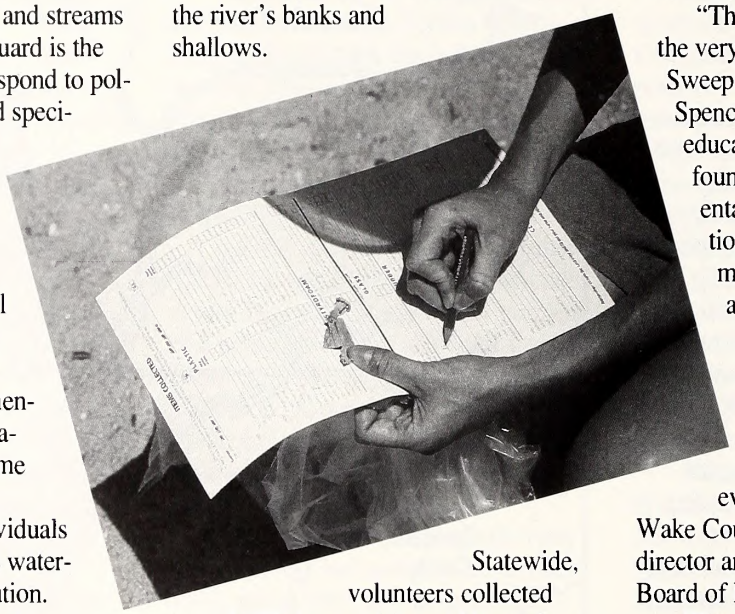
Catch of the Day: 195 Tons of Trash

More than 12,300 volunteers cleaned almost 195 tons of debris from the state's beaches, rivers and streams during First Citizens Bank Big Sweep '94.

Carteret County attracted the most volunteers — 1,742 — and likewise collected the most debris — 33,840 pounds. County Coordinator Eric Matthews had some volunteers who worked from dawn to dusk on Big Sweep day, Saturday, Sept. 17, as they collected trash from miles of county beach and estuarine shoreline.

Other counties with large volunteer turnout included: Brunswick, 696; Dare, 526; Davidson, 420; Guilford, 910; New Hanover, 792; Onslow, 448; and Wake, 728.

In the mountains, 90 volunteers took to their canoes to clean up the New River, pulling 319 tires from the river's banks and shallows.



Statewide, volunteers collected 1,708 tires, which would stretch more than three-quarters of a mile if laid end to end. The high incidence of tires and appliances such as stoves, refrigerators and dishwashers is probably a result of tipping fees at county landfills, says Susan Bartholomew, Big Sweep's executive director. Instead of paying the fees to dispose of large items at the landfill, some people dump them illegally, occasionally at the water's edge.

Across North Carolina, volunteers removed enough discarded appliances to outfit a dozen kitchens, toilets for two dozen bathrooms and furniture for a half-dozen bedrooms and family rooms. Add the 2,000 pieces of lumber collected in Rutherford County to a load of drywall picked up in Moore County, and Big Sweep volunteers had the beginnings for a modest-sized house.

Unusual finds included a bag of undelivered mail in Forsyth County, a buried car in Cumberland County, 35 shopping carts in Alamance County, an Easter egg with a dollar bill in Union County and pieces of a moonshine still in Stanly County.

Unfortunately, cleanup volunteers also discovered two dead, entangled animals. In New Hanover County, a dead pelican was ensnared in fishing line; in Hyde County, an otter skeleton was trapped in a discarded fishing net.

"These kinds of discoveries are the very reason why we began Big Sweep eight years ago," says Lundie Spence, N.C. Sea Grant's marine education specialist and one of the founders of Big Sweep. "Animal entanglement and debris ingestion by animals are two of the major negative impacts of aquatic litter."

And lessening these impacts is exactly why volunteers give four hours of their weekend time annually to this cleanup event, says Lois Nixon, the Wake County Keep America Beautiful director and president of the Big Sweep Board of Directors.

"People want a cleaner, safer environment for themselves and for the wildlife that lives and feeds along our shorelines," Nixon says.

When all the volunteers were counted and the litter weighed, Bartholomew saw two trends in this year's cleanup. Volunteer participation increased despite rains that washed out some mountain cleanups and reduced turnout at western Piedmont locations. And the tonnage of the debris collected dropped for the second consecutive year.

"Coordinators told me that sites that had been picked up during previous years were definitely cleaner," Bartholomew says. "We believe our anti-litter message and educational efforts are having some impact.

"But that doesn't mean our job is done," she says. "We still collected 195 tons of trash, and that means there are

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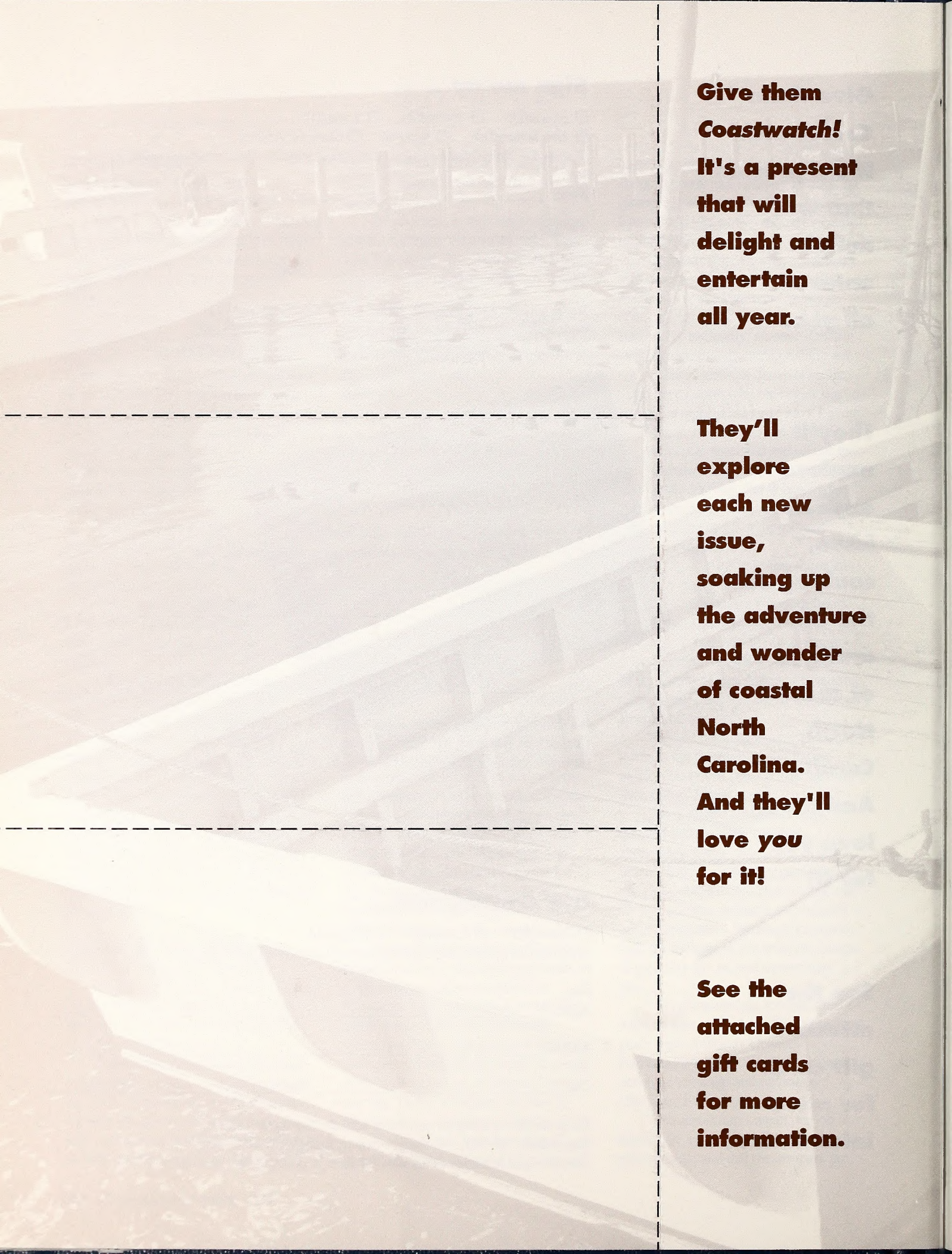

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plenty of people who still need to understand that trashing our waterways is bad for everyone."

First Citizens Bank is the title sponsor of the Big Sweep cleanup. Big Sweep gold sponsors include R.J. Reynolds Tobacco Co., WGHPiedmont 8, WRAL-TV, WSOC-TV, WITN-TV, WLOS-TV and WWAY-TV. Silver sponsors include Duke Power Co., Glaxo, IBM, Pepsi and Waste Industries.

N.C. Big Sweep is led by a board of directors representing First Citizens Bank; Carolinas Glass Recycling Program; Carolina Power and Light; Duke Power Co.; Keep America Beautiful of New Hanover County; Keep Wayne County Beautiful; N.C. Department of Environment, Health and Natural Resources; N.C. Division of Coastal Management; N.C. Division of Parks and Recreation; N.C. Sea Grant; N.C. Wildlife Resources Commission; Neuse River Foundation; Rowan County Parks and Recreation; R.J. Reynolds Tobacco Co.; Southeastern N.C. Waterman's Association; University of North Carolina at Charlotte; Wake County Keep America Beautiful; and WGHPiedmont 8.

Dunes Not Made For Walking

Sea Grant has produced an 11-by-15 inch poster entitled, "These Dunes Aren't Made for Walking." The poster names a few of the plants that anchor our ocean-front dunes and is a handy reminder to beachgoers not to trample this stabilizing vegetation. The poster was a spin-off from Sea Grant's series of "Sound Facts," which appear in coastal daily and community newspapers. If you'd like a free poster, write Sea Grant. Ask for publication number UNC-SG-94-04.

Back Issues of *Coastwatch* Available

If you're a new subscriber, you may wonder what you've missed from *Coastwatch*. Or you may want to purchase a particular back issue for a friend.

Sea Grant has a limited number of back issues available for $3 each. Here's a look at the past year's offerings.

January/February focused on closed shellfishing areas and pollution, seasickness and beach nourishment. March/April showed readers the scenery and history of Black River. May/June featured the wild horses of the Outer Banks and also described how to collect fossilized plants, seashells, bones and teeth in North Carolina's Coastal Plain. The July/August issue explored the unfolding public trust issues on the coast; it also featured stories on the women — migrant labor and coastal locals — in the crab-picking industry. In September/October, *Coastwatch* took a global look at the problem of marine debris, based on the findings of the Third International Conference on Marine Debris; the same issue also explored the practice of wildlife rehabilitation and discussed the pros and cons of this evolving science.

To order, send $3 to *Coastwatch* Back Issues, N.C. Sea Grant, Box 8605, N.C. State University, Raleigh, NC 27695. Discounts are available for bulk orders. For information, call 919/515-2454.

Grants Available To Enhance Fishery Resources

The N.C. General Assembly has provided $1 million for the establishment of a state program to enhance North Carolina's coastal fish resources. As a result, grants will be awarded to individuals who want to test new equipment, research industry trends, perform environmental pilot studies and study other fisheries issues.

"The Legislature has designed an imaginative program to tap the knowledge that we know exists in the fishing community for fishery enhancement and fishery management," says N.C. Marine Fisheries Commission member Dirk Frankenberg.

The commission will accept proposals from a diverse audience — including commercial fishermen, seafood/fishing companies, aquaculturists and recreational anglers.

Applicants must submit a written proposal by Jan. 16 to receive consideration for grant funding. Applicants are encouraged to focus their proposals in four areas:

- New fishing equipment and techniques, particularly those that reduce bycatch and impact on nontarget species and size classes.
- Fishing industry trends that identify new opportunities and strategies for developing and conserving state fishery resources.
- Environmental studies, primarily efforts that reduce adverse environmental impacts from fishing, restore fishery habitat and determine the environmental controls that affect fish and shellfish abundance.
- Fishery development efforts that will enhance coastal fisheries, such as improved seafood processing, new value-added seafood products and aquaculture.

Each proposal application must include a detailed description of the project, an explanation of how the project will enhance North Carolina's fishery resources and why it is innovative, projected costs for conducting the project and making its results available to the public, and biographical information documenting the experience and expertise of the project participants.

Proposals will be reviewed by the Marine Fisheries Commission, members of relevant commission advisory committees and the N.C. Division of Marine Fisheries and judged according to the quality, potential for public benefit, innovativeness, cost-effectiveness and qualifications of the participants. The commission will make the final decisions for funding, and grants will be distributed as evenly as possible among the northern, Pamlico, central and southern coastal areas.

Technical assistance for developing proposals and carrying out research is available from Sea Grant advisory personnel and the Division of Marine Fisheries district offices. For an application, call 919/726-7021. All applications must be postmarked no later than Jan. 16 and mailed to: Division of Marine Fisheries Director, P.O. Box 769, Morehead City, NC 28557.

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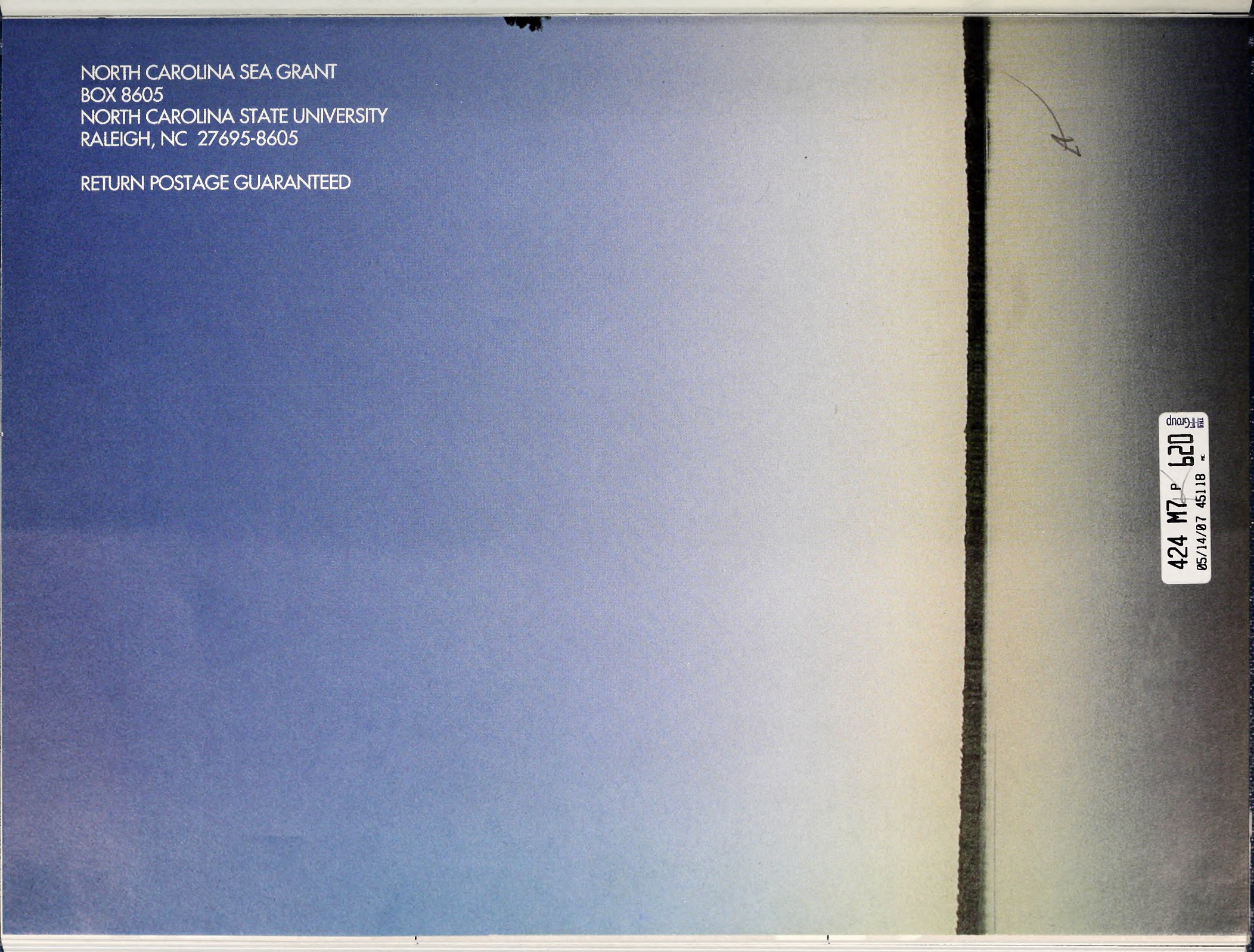

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